period of adolescence; it is liberal education for adolescence. The emphasis must be upon the individual not upon his means for making a living. It is the work of the secondary school, not to make a specialist, but to make a man who may become a specialist.

This period of adolescence demands studies that call gradually into play his developing faculties. They must increase in difficulty and they must begin to satisfy his desires to understand and see reasons and relations. The nature of secondary education is determined by the nature of *things*, not by nature of college requirements.

## III. THE DEPARTMENT CONFERENCES

In accordance with established customs the general conference resolved itself into departmental conferences for the afternoon sessions. The proceedings of these conferences are here given:

### THE BIOLOGICAL DEPARTMENTAL CONFERENCE

was opened, Associate Professor C. B. Davenport in the chair, by a paper by Mr. H. N. Whitford on "Physiography and Botany."

There is an intimate relation between topography and distribution of plants. In order to show this any definite physiographic unit may be selected. Such a unit is found in a sand spit near the biological laboratory situated at the head of Cold Spring Harbor, Long Island. The spit stretches some 2,000 feet into the water, dividing the harbor into outer and inner parts connected by a narrow channel through which the tide runs.

The inner side of the spit shows definite plant societies. Between high and low tides a greater part of the area is occupied by the large salt reed grass (*Spartina polystachya*). Nearer the limits of high tide narrow zones of the glasswort (*Salicornia*) and sea-lavender (*Statice*) are found. Where the topography is more level and only slightly covered by water at high tide the rush salt grass (*Spartina juncea*) predominates. Again there are patches of no vegetation near the limits of high tide. A greater part of the spit that stands above high tide is covered with the sand-reed (*Ammophila arundinacea*). On the outer side of the spit just above the limits of high tide is a narrow zone in which scattering specimens of the saltwort (*Salsola kali*) and sea-rocket (*Cakile Americana*) are present. The region between high and low tide is barren of vegetation except near the low tide limit where Ulva grows attached to

pebbles. Beyond the low tide level on both sides of the spit the eel-grass (*Zostera marina*) is abundant.

These facts concerning the distribution of the plants are significant. They mean that in the different zones there are certain sets of physical factors which make possible the existence of plants which have adapted themselves to those conditions. The salt reed grass zone is situated where it is free from being submerged by salt water a very short time twice a day. The rest of the time it is partly or wholly submerged. This grass has adapted itself to these conditions, but no other forms have adapted themselves successfully; therefore they are not found here. A corresponding zone on the outside of the spit is free from vegetation. One would suppose that here, too, would be a zone of salt reed grass, but such is not the case for physical factors not present on the inside of the spit are found here. The storm waves and tidal currents are strong. Directly these would tend to uproot any plants that could start; indirectly they transport the finer particles of soil and leave only the heavier parts. Thus a pebbly beach unfavorable for seed germination is the result. So each zone has its own set of factors which determine the plant or plants that occupy it. It must not be understood that there are sharp lines between the plant societies; indeed, they grade imperceptibly into one another.

The physical factors that have made possible the spit as it is now are still working and thus gradually changing its topography. This means that the zones of plants will be adjusted to meet the new physical conditions. For instance, if the salt reed grass area be filled up so that the length of time it is out of and under water is different from that of the present, conditions are brought about that will no longer make it possible for the salt reed to grow. But these conditions may be exactly what is necessary for the rush salt grass society.

Vegetation also aids in changing the topography of the spit and the adjoining portions of the sea bottom.

As stated, this is given as a type for study. It is believed that such a problem can be worked out by a high-school student in botany provided he has had the proper training in physiography. A great many facts concerning the structure and habits of plants can be brought out incidentally. Differences in topography can be found everywhere, and problems showing plant society development are abundant.

Dr. C. B. Davenport presented a paper upon "The Animal Ecology of the Cold Spring Beach."

On the outer, sandy beach one finds on the pebbly shore, numerous minute insects known as Thysanura or spring-tails. These are found at low tide nearly to the water's edge and spread upwards to six feet or so from the high tide line. The lower limit moves downward as the tide retreats, As it returns the spring-tails partly retreat and partly rise upon its surface, so that the water is covered with floating spring-tails. These are here to feed on the ground-up organic débris dropped by the tide.

At the high tide line a mass of wreckage is dropped at "slack water." This consists largely of decaying sea lettuce (Ulva) and drowned insects, especially beetles. This rich feeding ground, renewed twice a day, has attracted a distinctive fauna. The beach fleas and the rove beetles feed on the decaying vegetation; the ants that nest just above high tide carry away the stranded insects; running spiders prey on the young beach fleas.

On the *inner edge* of the sand spit, only a hundred feet away, the fauna is very different at the high tide line, just as the vegetation is. Here one finds the fiddler crabs; and just as the Salicornia is replaced by the Statice near the distal end of the spit, so is one species of the fiddler crab replaced by another. The conditions that determine the occurrence of the plant species determine that of the animal species also.

In the channel, through which the tide is nearly always rushing, there occur isolated bunches of the large salt-reed. These hold together the muddy substratum by their roots. But the mud would be washed away by the swift current were it not protected by a retaining wall of mussels. The mussels are themselves, in turn, afforded a favorable foothold where the food-bringing current runs swiftest.

A comparison of the marine beach on the sand-spit with the beach of Lake Michigan is instructive, for here, at a distance of eight hundred miles from the sea, we find the same assemblage of animals, excepting those that are exclusively marine. Similar Thysanura, carrion flies, rove beetles, robber flies, tiger beetles, ants, spiders, and sand colored grasshoppers. These occur also in definite zones. The lake beach at Chicago is worthy of especial study. A similar relation of animals to habitat will be found, although perhaps not so clear, on the dunes, in sandy spots, in clearings, and on the edge of lakes and streams. High-school students should certainly have their attention directed to these phenomena and seek an answer to some of the problems presented by animals in relation to habitat.

This was followed by a paper by Dr. H. C. Cowles on "A Comparison of Lake and Marine Beaches as to Ecology of the Vegetation." He said in substance:

At the present time there seems to be a tendency to relate different subjects more fully than we have done in the recent past, and thus escape the evils incident to narrow specialization. Perhaps it is not too much to hope that we may again have "naturalists." The Cold Spring Harbor spit shows the necessity of combining physiography, animal ecology, and plant ecology in order that one may fully understand either branch.

In comparing lake and ocean beaches the most striking result is found in the resemblances. Below the water-line there are differences, as one would expect, owing to the presence of salt water in the one case and fresh water in the other. Above the water line the flora is strikingly similar on lake and ocean. There is in each case a naked plantless beach just above the water line. In each case the pioneer plants are the same, viz., the sea rocket (*Cakile Americana*), the sea spurge (*Euphorbia polygonifolia*), the beach pea (*Lathyrus maritimus*). Farther back on the dunes, the most characteristic plant is the sea sand-reed (*Ammophila*); many other species are the same in the two cases, while very few species are different. Even on the Pacific coast several species are to be found which characterize our eastern beaches.

Whatever the ecological significance of the resemblances just noted their practical significance is clear, viz., that the facts of physiographic ecology are widespread rather than local. Hence it becomes possible for secondary schools to take up local problems with the assurance that they will have much more than local importance. The interpretation of nature, the attempt to find out why some plants or animals are in one situation and others in another is surely a fit topic to claim part of the attention of biology teachers and students in secondary schools.

In the discussion of these three papers the question was raised as to whether it would be practicable to apply these ideas in the secondary schools of Chicago or not. Dr. Davenport thought that a line of work might easily be developed on these lines which would be successful.

Dr. Cowles said that the important thing is to study nature from the standpoint of interpretation. The particular advantage of what we may call physiographic biology is that it is the phase of biology which the pupil will meet in after life. He will be

continually seeing rivers and lakes and hills ; and should understand their relation to animals and plants.

The objection was raised that the pupils will merely take the relations taught for granted, and that there will be no training in working things out for themselves.

Drs. Cowles and Davenport replied that there were many simple relations which they could work out for themselves.

Mr. Westgate related his experience in Kansas with two divisions of about twenty-five pupils each, in which the change was made from taxonomic to ecological study. They had field work twice a week. Both pupils and teachers were very well pleased with the change.

Miss Gloss thought that this sort of study was useful in making one see the things themselves as well as their relations.

Mr. Cole asked if the average pupil understood animals and plants well enough to be ready to go out and appreciate this work. He compared it to the late methods of teaching reading where the word is taught before the syllable, at the expense of the development of analytic powers. "Ecology is the sentence as a whole." "Laboratory work is the study of the alphabet." We should first build up the words from the letters.

Miss Snively agreed that acquaintance with individuals should come first, but thought that such instruction should come much earlier, so that the pupils would be ready for this sort of work by the time they reached the secondary schools.

Miss Barbour said that studying animals and plants in their relations was the place to begin. Study their homes, etc., first. Otherwise we are like those who are able to read, as far as pronunciation goes, a foreign tongue, but do not understand what is being read.

Dr. Cowles confirmed what had been said on both sides. The point he wished to make was that the pupils should be started as soon as possible in this line of work, that it is the important thing and should not be neglected.

Mrs. Cowles spoke of the methods used by Dr. Davenport at Cold Spring Harbor, viz., get the animals in their habitat and then bring them into the laboratory for further study and

acquaintance with them as individuals. This plan seemed to her to unite both views that had been expressed.

The next paper was on "Bird Study in City Schools," by H. E. Walter, Robert Waller High School, Chicago.

Bird study in city schools resolves itself naturally into the identification of birds during the spring migration. The fall migration is too difficult, owing to the imperfect plumage of the birds, while the study of nests and nesting habits is largely out of the question in city parks during the school year. Yet the same result that is sought for in the discipline of ecological study, namely, of training the pupil to really *see* things for himself in order that he may, as Dr. Cowles has said, "travel throughout life by day instead of by night," may be gained also by this other method.

Last spring eight of the fifteen public high schools in Chicago did some definite work with the bird migration. The particular method now to be explained was followed out in our school and it is given, not because it is the best way nor because it may be adapted to other cases, but because it is the evolution at which we, with our conditions, have arrived after five years of experimenting.

Before the migration begins in March three bird talks are given near by at the Academy of Sciences, illustrated by mounted specimens. The object of these talks is to enable the pupils who attend to identify some hundred birds when seen alive. The substance of these helpful notes and hints has been published in convenient pocket form under the title of *Wild Birds in City Parks*, and this little book is placed in their hands. They are now ready to begin going out mornings before school on the lookout for the first arrivals.

A large bulletin is begun at the school on which the name of each new bird is placed, together with the name of the pupil who is the first to identify the same to the satisfaction of the teacher. By rejecting rigidly all doubtful evidence and insisting on descriptions which are convincing, this bulletin hung prominently in the laboratory, becomes a sort of roll of honor and is a great incentive to accurate seeing. In addition, each pupil keeps a daily record on file in the laboratory, of all birds seen by him and in this record he is allowed to express his own untrammeled beliefs as to what he has seen — from English sparrows up to birds of paradise — regardless of what the teacher's verdict may be. It is interesting to note that the pupils honestly attempt to make these individual record cards reliable. They understand that their ornithological reputations are at stake. The fact that most pupils

begin when only a few birds have arrived, and that they see these repeatedly until they become sure of them, while each morning presents only a limited number of strangers, explains how it is possible to come to know quite well upwards of a hundred birds during a single spring migration.

The whole business is kept distinct from and independent of the regular school work. Only those who really want to do so take any part in it, and they are given no extra credit in their regular biology work. In fact they sometimes get up so early and stay out in the morning air of the park so long that they become sleepy and dull later in the day and their biology marks suffer in consequence!

Pupils are not urged into bird study. The teacher never descends to drumming up trade. The initiated pupils always attend to that. Many of the veterans of the previous spring are found among the green beginners, to whom they pass themselves off as oracles of ornithological wisdom. Most attention is given to the *best* pupils instead of, as is ordinarily the practice in regular classes, trying to prod up the hindermost. Consequently pupils learn that they are going to get out of this affair just what they themselves put into it, and not what the teacher gets out of them.

In order that the bulletin list may be a fair competition, the teacher *never identifies any bird for any pupil*, but simply confirms correct diagnoses. Excursions are avoided. Whenever by chance several happen to group together in the neighborhood of the teacher they are advised to scatter out. In fact his time in the park is often divided between watching for birds himself and in dodging those pupils who ought to use their own eyes and exercise their own judgment instead of his.

Any tendency on the part of certain pupils to vaporize or to substitute small talk and superlatives for real observation and appreciation of the birds is discouraged, and the attempt is made to give the whole subject dignity. In fact, as soon as it comes to be understood that the teacher is out because he wants to see the birds for himself, and is not out hunting pupils, the whole matter becomes worth looking into.

This early morning work enables the teacher to come into relations of comradeship and equality with his pupils that he may strive for in vain in the schoolroom where war is always tacitly declared. The best results of all for the pupil is forming the habit of really seeing things with his own eyes. This lays the foundation of the true interpretation of nature.

It was asked, what the chances for such work are in those parts of the city where there are no parks. Mr. Walter said that there would probably be at least seventy-five birds to be seen in any back yard where there are trees, and even where there are no trees there would be birds if anything.

Mr. Howe was of the opinion that bird study is essentially ecological. We must necessarily know a bird's habitat to be able to find it. "It is a study of distribution with reference to environment."

Mr. Walter said that while that was true, still most of the work consisted in plain identification of birds during migration, *i. e.*, out of their normal habitats.

Miss Snively told of her methods. She makes the pupils acquainted with the birds by study of skins. The children then colored sketches, and by that time were able to identify the birds as they saw them.

THE CHEMICAL SECTION OF THE CONFERENCE

met in Kent Chemical laboratory with Associate Professor Alexander Smith in the chair.

The first paper, of which an abstract follows, was read by Miss May M. Butler, of Riverside High School, upon the subject:

"The Treatment of the Science of Chemistry for Instruction in Secondary Schools; Is it Becoming too Academic?"

In our schools the course of study is planned on a more or less sociological basis, but when one comes before a class, what is taught in a subject and how it is taught depends, of course, on the point of view of the teacher, on the end at which he is aiming.

There are two points of view which control instruction today. One, to put it in an extreme way, where the end aimed at is the accomplishment of a certain *amount* of work, the amount and kind being determined by the scientifically trained adult mind, his mental attitude being imposed on the pupil. The object in view is to get the work done in the hope that somehow, in some mysterious way, the untrained youthful mind may develop by going through this amount of gymnastics.

The other end aimed at in instruction is the development of the power of the pupil and the enriching of his experience in his present

life among his fellows, the subjects chosen for certain periods being suitable to the stage of mental development and the present life interests of the pupil. Not only the subject, but the way of looking at the subject, is thus determined. The object to be attained in such instruction is to develop in the pupil the power to set up certain ends worth while and the ability to realize these ends as far as possible independently.

These two points of view, the first where emphasis is thrown on the work as the the thing worth while, the pupil being there to accomplish it; the second where emphasis is thrown on the developing of the pupil in his *life relations* as the thing worth while, the work being there as material for him to work over into his experience, thus broadening and deepening it, the material being something *real* to the pupil in his relations to life, not merely a sort of exercise to be gone through that he may be developed, these two points of view determine also the use made of text-books.

A teacher with the first point of view would prescribe the text as a beneficial allopathic dose to be taken from cover to cover, and laboratory work in science to be done exactly according to directions.

One with the second end in view would use the text as a source of information with which to broaden the experience that the pupil had already acquired by individual, independent experimentation.

Work in chemistry carried on in this way begins with a general discussion of the subject in hand based on the facts already known to the pupils. In this the teacher controls the trend of the discussion without adding information. The pupils know that certain facts are true. From these they infer that other things would be true. As there is always a tendency to lose sight of some of the controlling factors in natural phenomena and thus to make groundless assertions, those inferences and suggestions made by the class, not perfectly self-evident, are put by the class into the form of problems to be investigated.

Some of these problems are investigated by the individual for the benefit of the whole class, thus giving him a motive for careful work and clear explanation thereof. Other problems are investigated by the whole class, but with different materials, so as to give a broader basis for drawing conclusions; others are investigated by the whole class with the same materials, so that an average result of a larger number of data can be obtained. As an illustration, this year, after a few preliminary experiments, our first subject of study was water. In

the introductory discussion it was brought out that there were three large problems that they might investigate in reference to water: (1) The solvent action of water; (2) where water is found in nature other than in masses; (3) the chemical structure of water.

These problems, as they were taken up, were subdivided into many minor ones, such as: (1) Are solids in general unequally soluble in cold water? (2) Does an increase in temperature increase the solubility of solids in like degree? (3) Are liquids equally soluble in water? (4) Are gases equally soluble in water? (5) What effect has an increase in temperature on the solubility of gases? (6) What effect has a decrease in pressure on the solubility of gases? Such a problem as the first should be solved by the whole class using as large a variety of solids as possible, so as to give as broad as possible a basis for conclusion. . . . .

The pupils are required, so far as is in their ability, to devise their own methods of solution, and to choose suitable apparatus. Thus, the properties of materials which have to be controlled in order to obtain the desired end force themselves on their attention. Devising their own methods develops considerable ingenuity, and often better results are obtained because the students have the method of procedure better under control than they would if it were some one else's method. Their work is less mechanical. A pupil who devises his own wash-bottle for washing a gas, or a safety-bottle, never attaches his wash-bottle with the wrong tube foremost, or uses a wash-bottle for a safety-bottle.

After the problems have been investigated, the pupils report their results to the class, and each pupil records the data, also the apparatus, and method of procedure, when the experiment has been performed by the individual for the class. From these they write up permanent notes.

The four preceding steps of the work — that is, (1) the general discussion; (2) the making of problems to be investigated; (3) the solving of these after an individually devised method; (4) the generalizations made from the work of the class — are broadened by reports from the text, so far as it supplies material, and from reference books which give condensed reports of other men's work along the same lines.

That pupils are capable of thinking out a related series of problems and from them forming some appreciation of truly scientific work may be illustrated by the following set of problems, thought out step by step by the class last year.

The large problem in hand was to determine the chemical structure of water. After having found out by electrolysis that hydrogen and oxygen could be obtained from water and sulphuric acid in the approximate proportions 2 : 1 they did not know whether the gases came from the water, or the sulphuric acid, or both. So it was proposed to unite hydrogen and oxygen in the proportions 2 : 1 to see whether water was obtained. This necessitated the following investigations: (1) Can hydrogen be obtained from an acid and a metal? (2) Does the concentration of the acid effect the result? (3) Which combination of acid and metal produces the largest quantity of hydrogen? (4) Will oxides give off oxygen when heated? (5) Which oxide gives off the largest quantity of oxygen?

After having obtained oxygen and hydrogen from the best materials, and having united them in the proportions 2 : 1 or what they thought was 2 : 1, when the result was not what they thought it would be after several repetitions, they began to look about for sources of error, and the following problems were suggested: (1) How does the volume of a gas vary with the pressure, the temperature being constant? (2) How does the volume of a gas vary with the temperature under constant pressure? Then a recalculation of data after several more repetitions gave approximately correct results.

When the reference reading on the determination of the structure of water by different scientists was done they called attention to the fact that Morley did the experiment twenty times before he was satisfied with the results and that Cavendish's method was neater and more simple than theirs.

As to the relative merits of these two methods of instruction:—The one, where the pupil is given a manual with full directions for each experiment which he performs carefully, gives him a narrow view of the subject. He knows, for example, only one or two ways of making oxygen and hydrogen, and each experiment, to him, must be set up in one definite way. He forms also no appreciation of the significance of scientifically accurate results.

The second method gives the pupil more command of the subject, more breadth of view and independence in work and thought. He has materials under his control better and is better prepared to go at further work in a scientific way.

There is a tendency to make the work too academic if the present text-book is chosen with the intention of getting it into the pupil's memory from beginning to end. There isn't any danger, however,

if the teacher keeps the pupil's ability to think and work constantly in mind.

In the general discussion which followed the reading of the paper, it appeared that some of the members of the conference thought that the heuristic method, as outlined in the paper, would not yield satisfactory results in practice. It was thought that, by a strict application of these principles, the student would be able to cover very little ground. Such a course was called nature study, and not chemistry. How can the student be expected to invent those processes and discover those methods which have been the result of the work of years of skilled chemists? How, for example, could a student be asked to construct a wash-bottle? The teacher may make suggestions, but these would have such great influence in shaping the student's view that it was thought better to give definite and complete instructions at the start regarding the experiments to be performed. In the replies to these criticisms it was pointed out that the aim of a secondary-school course in chemistry is not to turn out finished chemists. The aim is not to confer a definite amount of chemical information or to require the performance of a certain fixed number of experiments. Its real object is to develop the mental power by logical reasoning and appropriate methods of experimental investigation. At the same time the work done leads to results which are of real worth as an accession to the pupil's fund of useful knowledge. They have an additional value in that he knows just how they were obtained. He has learned from his own experiments the way in which all scientific knowledge is obtained.

It was admitted that it would be unreasonable to expect the pupil to rediscover any very great amount of chemistry. He may learn much, however, from very simple experiments. For example, it is not too much to expect him to discover how and why iron rusts in the air. He may study with success the question of solubility or condensation of steam. It was thought better to give simple problems and let the pupil work them out for himself. Even if the pupil fail to discover the solution of any given problem, he is benefited by having thought about it.

By allowing students to devise their own experiments the habit of independent thinking is greatly developed. This is probably the most important argument in favor of the heuristic method. It was the opinion of many that, although a course should not consist entirely of work of this sort, an infusion of a considerable portion of such work, even if it diminished the ground covered, would be exceedingly valuable.

The following persons took part in the discussion: Messrs. Abels, Ames, Boynton, Burns, Easton, Flynn, Hawthorne, Linebarger, Meslick, Alexander Smith, A. L. Smith, Spicer, Walker, Watson, and Misses Chapin and Butler.

The second subject was on "A Minimum Outline of Chemistry for Secondary Schools." The discussion was opened by Mr. C. M. Wirick, of the English High and Manual Training School, Chicago. The speaker indicated his object in teaching as twofold. First, training, and, second, to give the student enough chemistry to understand the universe. The outline included a selected list of topics. It cannot be given here as there is not space to include the remarks showing the aspect of each subject to be presented and the mode of relating each to the others.

Mr. Flynn, of Hyde Park High School, the second speaker upon this topic, stated that his outline would be even less extensive. He favored the omission of the ionic theory and also of the law of Avogadro, as the latter is too important to be treated briefly. He also thought it was not necessary to try to write accurate and complete equations to represent chemical actions. The course as outlined included the following: Fuel, air, hydrochloric acid, acids, bases, oxygen, basic oxides, acid anhydrides, sulphuric acid and compounds of sulphur, nitric acid and oxides of nitrogen, ammonia; and the following typical metals: sodium, potassium, calcium, copper, mercury, silver, aluminium.

After the discussion of the above papers, Dr. Linebarger described several new experiments. Dr. Walker described the method of preparation of Welsbach mantles and exhibited samples of the mantles and burners.

## THE CONFERENCE IN ENGLISH

ASSOCIATE PROFESSOR HERRICK, Chairman.

The conference of 1900 had demanded greater latitude in the teaching of English literature and the history of English literature than is provided for in the university entrance requirements. The English department, in considering the advisability of modifying its entrance requirements, made a thorough investigation of the curricula at present established in the secondary schools. A report, based upon this investigation, was made by the departmental examiner.

The following facts were emphasized in this report:

1. The high-school course is too brief to permit of more instruction in English literature than is provided for in the university entrance requirements.

2. Teachers who have mastered the English classics, included in the university list, find them the most effective instrument for teaching the history of English literature.

3. The present need is not for a modification of the university entrance requirements, but for a body of teachers so trained as to be able to use the English classics, included in the university list, intelligently and effectively.

Other facts, revealed by the investigation, but not bearing directly upon the question before the conference, were as follows:

In many schools the entire instruction in English literature and composition is in the hands of a single teacher. Inasmuch as one teacher, unassisted, cannot simultaneously conduct four classes in English literature and four classes in English composition, a compromise has been adopted in many schools by which approximately two years are devoted to each subject. As a result, students from these schools enter the university without a thorough appreciation of the English classics and with inadequate training in English composition.

In the general discussion following the reading of the report, the demand for greater latitude in the choice of supplementary reading was renewed. Upon the motion of Professor MacClintock, provision was made for a committee, whose duty it will be to prepare a list of supplementary readings for the use of secondary schools.

### THE CONFERENCE IN FRENCH

MR. H. PARKER WILLIAMSON, Chairman

The first paper, on "Composition," was read by Miss Berthe des C. Favard, of the Hyde Park High School. She spoke for simplicity in composition and for the unity of the phrase. Miss Favard spoke in French and presented a carefully written paper.

The second paper was by Professor Monin, of the Armour Institute. He treated the subject: "What French and how much French should be read in the first year of a college preparatory course?" His main points were for some scientific reading and emphasis on dictation.

There was discussion between M. Sicard, Dr. Pietsch, and Dr. Jenkins.

Dr. Pietsch stated that hereafter the instruction in French in the Romance department will be given along the lines recommended by the *Report of the Committee of Twelve*, the study of which he warmly recommended to the attention of the teachers.

### THE CONFERENCE IN GERMAN

DR. P. O. KERN, Chairman

1. In accordance with the motion passed at the last annual conference, a committee of five representing the university, the affiliated, and the coöperating schools had been appointed to revise the list of books prescribed for second-year reading. Its report, agreeing in substance with the recommendations of the Committee of Twelve of the Modern Language Association of America, was submitted by Mr. Karl Seeligmann (Harvard School), chairman, and accepted. These new requirements for German 2) which will go into effect September, 1902 (optional until that date), are:

This examination calls for the reading of about 400 pages of moderately difficult prose and poetry, with constant practice in giving, sometimes orally and sometimes in writing, paraphrases, abstracts, or reproductions from memory of selected portions of the matter read; also grammatical drill upon the less usual strong verbs, the use of articles, cases, auxiliaries of all kinds, tenses and modes (with special reference to the infinitive and subjunctive), and likewise upon word order and word formation. Suitable reading matter (five

books) must be selected from the following : Andersen's *Märchen*, or Andersen's *Bilderbuch ohne Bilder*, or Leander's *Träumereien*—to the extent of about forty pages; after that Hauff's *Das kalte Herz*, or Zschokke's *Der zerbrochene Krug;* then Hillern's *Höher als die Kirche*, or Storm's *Immensee;* next one of the three selections in Nichol's *Karl der Grosze nebst zwei andern Bildern aus dem Mittelalter* (Freytag), preferably *Aus dem Klosterleben;* or Schiller's *Wilhelm Tell;* lastly, Benedix's *Der Procesz*, or Wilhelmi's *Einer musz heiraten!*

2. The main feature of the program was the discussion of the question: "Should teachers of German aim at some acquaintance with the historical development of the German language and literature?" The subject was introduced by two papers given below, which were followed by a lively debate, the final decision being in the affirmative. Members present, 50.

## THE LINGUISTIC ASPECT OF THE QUESTION

DR. KERN

I wish to present this afternoon some of the points in which a knowledge of the historic development of the German language has been of practical help to me in teaching the German of today to elementary classes.

1. After a few introductory remarks about the relation between the English and German races, the study of cognates may very well be begun with the first vocabulary. The law for the changes in the consonants may be discovered by the class or, according to the method pursued, briefly stated by the teacher. Take, for instance, the dental series; of what beautiful simplicity are rules such as: To English *d* corresponds *t*, to English *th*, *d* in German. Can a teacher afford not to avail himself of these? Starting with the English the teacher can make his students construe the consonantal skeleton of hundreds of German words, *e. g.*, *beam—Baum*, *hail—Hagel*, *nail—Nagel*, *light—Licht*, *wight—Wicht*, *dapper—tapfer*, *pepper—Pfeffer*, *stroke—Streich*, *token—Zeichen*, *pea (cock)—Pfau*, *plight—Pflicht*, *leap—laufen*, *soap—Seife*, *tiding—Zeitung*, *timber—Zimmer*, *twig—Zweig*, *water—Wasser*, *scuttle—Schüssel*, *thatch—Dach*, *loath—leid*, *cloth—Kleid*, *heath—Heide*, *harvest—Herbst*, *starve—sterben*. The few exceptions may be ignored in the beginning. The English consonants being usually the original ones, all that the instructor has to know is the second sound-shifting which separates the high German consonantal system from that of the rest of the Germanic languages. The larger German grammars give the

results of this important process in a clear form, the task of mastering them is easy and the teacher is amply repaid for his labor by the amount of memorizing which he spares his class.

Not unfrequently, however, cognate words differ not only in form but also in meaning in the two languages. Though here general laws cannot be established, the change ought to be explained in every individual case, *e. g.*, *fee—Vieh* (cf. Latin *pecus*, *pecunia*), *stove—Stube* (originally the room that could be heated), *town—Zaun* (the old towns were fortified), *read—raten* and *lease* (glean)—*lesen* (guessing and picking up of the *Buchstaben*), *write—reiszen* (cutting of the Runic characters in the wood; *Reisznagel*, *Reiszbrett*, *Abrisz*), *shrive—schreiben* (dictating a punishment), *cup—Kopf* (cf. Latin *testa*—French *tête*, German *Tassenkopf*), *top—Zopf* (even the men wore their hair tied up on the top of their heads), *lunacy*, *avoir des lunes*, Latin *luna—Laune* (relic of the mediæval belief in the influence of the moon on the disposition). Sometimes we notice a development of meaning in *malam partem* in one of the languages as in the following instances: *knave—Knabe*, *knight—Knecht*, *slight—schlecht* (but: *schlecht und recht*), *lust—Lust*. At other times we notice a narrowing down of the meaning as in *dumb—dumm*, *small—schmal* (but: *schmälen*), *fret—fressen*, *vane—Fahne*, *titter—zittern*, *chafer—Käfer*.

The introduction of such bits of culture-history, of philosophizing or whatever else may have caused the change in a given case, all this will enliven the dullest vocabulary. The added human interest will make the word cease to be a mere form to the student and change the committing of new words to memory from an irksome task into a pleasure. In his attempt to connect the meanings of cognates, the teacher will now and then be compelled to go back to the fundamental meaning, as in: *sad—satt* (fundamental meaning: *heavy; sad bread, sadiron*), *dimple—Tümpel* (root meaning: *tief sein*), *clean—klein* (originally: *shining; Kleinod*). In most cases *Kluge's Etymological Dictionary*, *Paul's Deutsches Wörterbuch*, or *Eberhard's Synonymisches Handwörterbuch der deutschen Sprache*, Leipzig, 1896, will easily furnish the teacher the necessary information.

2. In the nominal inflection the decay of the English endings due to the strong stress on the first syllable, and the crowding in of French *s* as a sign for the plural have almost entirely effaced the old Germanic declensions and their classification. Yet the little that is left can well be utilized in the German class room. It may be pointed out that the *s* of the German strong genitive survives in the English possessive

which has been generalized. For other remnants of Germanic inflection we must turn to the so-called irregular plurals in modern English. *Mice, teeth, geese,* etc., belong to the strong declension and illustrate the umlaut as *men* and its compounds do. Such words as *children, brethren, oxen* introduce the student to the German weak declension. The uninflected plural of the first strong declension finds its parallels in two classes of modern English words. The first class consists of such collectives as *deer, sheep, swine, horse,* Anglo-Saxon neuters that did not take an ending in the nominative and accusative of the plural. Alike in singular and plural, both in Anglo-Saxon as well as in Old High German, were further such neuters as *year, Jahr, pound, Pfund.* This accounts for such constructions as *a three year old child, a ten pound note, drei Jahr alt, zwei Pfund Zucker, sechs Mal,* and leads to the modern German rule that all but feminine nouns expressing weight or measure do not take the sign of the plural. The masculines followed the neuters by analogy, *a three foot rule, drei Fusz vier Zoll;* the majority of the feminines were weak and have always had a characteristic ending for the plural. As the uninflected plural cases of the neuters, traces of which are found even in New High German (*e. g., Kind und Kindeskind=children and grandchildren*), did not admit of a differentiation from the singular, *er* and *e* become the new signs of the plural. *Die Feld, die Haus* become *die Felder, die Häuser* while the old datives survive in proper names, *e. g., Rheinfelden, Schaffhausen. Er,* which already occurred with Old High German neuters, becomes so common that it even enters the inflection of the masculine. It gives rise to that class of masculine nouns that follow the paradigm *Wald, Wälder;* vacillation between the masculine and neuter genders (*Gott*) or analogy to neuter nouns (*Wälder–Felder,* but *Unterwalden; Männer–Weiber, Kinder*) ushered in this confusion. *E,* originally the ending of the strong masculines, now forms a subdivision of the second strong declension : *Jahr, Jahre.* The two ways of forming the plural may be observed on the same stem : *Lande, Länder; Worte, Wörter,* etc.

In the weak declension, the annoying mistake of giving the strong inflection to the well-known list: *Fürst, Graf, Herr,* etc., may easily be avoided by pointing out that these nouns only recently lost their final *e* and ought to be grouped with *Knabe.* They occurred frequently as titles, *i. e.,* before accented proper names, and thus were naturally shortened. Many deviations from the modern weak norm might easily be mentioned here. *Festgemauert in der Erden, Röslein auf der Heiden,*

*Darf mich leider nicht auf der Gassen, So wird doch Deiner Seelen der Bräutigam nicht fehlen* or such compounds as *Sonnenlicht, Harfenton, Erdenkind or Ich rufe Paulinen* and similar survivals of older usage are well explained in *Friedrich Blatz, Neuhochdeutsche Grammatik mit besonderer Berücksichtigung der historischen Entwicklung der deutschen Sprache, 2 Bände, Karlsruhe, 1895,* also in *Karl Gustaf Andresen, Sprachgebrauch und Sprachrichtigkeit im Deutschen, Leipzig, 1892.* Neither book presupposes a knowledge of the old Germanic dialects.

I cannot leave the noun without referring to the mixed inflection which is difficult to handle because it follows so closely in the wake of the four declensions. A good list of the more common mixed nouns is given in *Joynes-Meissner, Lesson V,* of course without explanations. The subject being somewhat complicated, I will take up only a few words of this class. To show how easily a confusion might arise, it is a good plan to write two Early Modern High German paradigms side by side, that of the strong noun *Wagen* and any weak stem:

| | | | |
|---|---|---|---|
| *Wagen* | *Name* | *Wagen* | *Namen* |
| *Wagens* | *Namen* | *Wagen* | *Namen* |
| *Wagen* | *Namen* | *Wagen* | *Namen* |
| *Wagen* | *Namen* | *Wagen* | *Namen* |

The only difference between these existed in the nominative and genitive of the singular which led to modern *des Namens* and to the by-form *der Namen.* Sometimes we find a strong verbal noun of the same stem by the side of a weak noun: *das Glauben, des Glaubens–der Glaube, des Glauben; das Schaden, des Schadens–der Schade, des Schaden.* In some cases the cause of the confusion was a change of gender: *Stachel, Mast, See,* now masculine nouns preserved their old feminine plurals. In the modern singular *Sporn* we really have an old plural (*a pair of spurs*), the old singular being still retained in the proper name *Spohr* (= English *spur*). At present this word has three plurals: *Sporen* (the historically correct and best form), *Sporne* (from the new singular, perhaps under the influence of *Dorne*), and *Spornen,* the youngest formation, a contamination of *Sporen* and *Sporne,* or in analogy to *Dornen.* Others of these nouns as *Bayer, Stiefel* were formerly strong and needing a distinguishing feature took *n* in the plural. Others again as the weak *Vetter, Bauer* were drawn over to the first strong declension by *Vater, Bruder.*

3. The Verb. In the strong conjugation the fact that the older periods of German as well as English possessed four principal parts explains a number of forms which would have to be treated as irregularities from

the standpoint of today. The old preterit embraced two principal parts, one vowel occurring in the singular indicative and usually another in the plural and the subjunctive. The Middle High German principal parts of *werfen* were, *e. g.*, *werfen*, *warf—wurfen*, *geworfen*. As a rule a leveling out took place in Modern High German; sometimes, however, we find the two old forms retained. Thus we find the old vowel of the plural not unfrequently in the classics of the eighteenth century. On account of the rhyme the proverb remains: *Wie die Alten sungen, so zwitschern die Jungen.* The modern poetic forms *thät*, *thäten* are not subjunctives but old indicatives; Schiller says: *Ich thät's vor kurzem selbst erleben*; Uhland: *Er thät nur spöttisch um sich blicken.* The old preterit of *thun* was *thet—thaten*, later on the vowel of the plural was generalized. Leveling out in favor of the vowel of the singular, we find in Goethe's: *Die Augen thäten ihm sinken.* General is the retention of the old vowel in the preterit subjunctive of such verbs as, in the spoken language, would not have differentiated their new subjunctive from the present indicative: *würde* (*wärde* = *werde*), *würbe* (*wärbe* = *werbe*), *gülte* (*gälte* = *gelte*), *hülfe* (*hälfe* = *helfe*), etc. The historically correct preterit of *werden* is *ward—wurden;* not only did *wurden* survive, it even entered the singular as *wurde.* By calling the modal auxiliaries pretrit-presents, *i. e.*, old strong preterits in form that later took on the meaning of presents, they can easily be explained in this connection. *Darf—dürfen*, *e. g.*, goes like *ward—wurden.* Their new preterits and participles were then naturally weak, they were formed upon the plural the vowel of which occurred most frequently in the tense: *dürfen*, *durfte*, *gedurft.* Compare modern English *dare*, *durst* or the vulgar *he had ought to go.* At this juncture I should like to call attention to a mistake not yet eliminated from a number of grammars which continue to translate *to dare* by *dürfen. Dürfen* is not cognate with *dare.* Old High German *durfan* corresponds to Anglo-Saxon *thurfan* which is lost in Modern English. The cognate of *to dare* is Luther's *ich tar*, *wir türren* which, in the seventeenth century, shared the fate of English *thurfan.* Passages in which the meaning of *dürfen* has changed to that of *dare* may be found, it is true, in Fischart, Opitz, Grimmelshausen, Hagedorn, and in Swiss authors, but they are rare and not upheld by present usage.

A question occurring whenever a class comes to *gehen* and *stehen* is why these two strong verbs are not conjugated *du giehst*, *stiehst*, etc. By putting *ging*, *gegangen* side by side with *fangen*, *fing*, *gefangen*, it

can easily be shown that *gehen* is irregular; it is a different stem. The old infinitive *gangen* now lost to the literary language survives in the dialects as does the Scotch *to gang*. *Gehen*, English to go, had as some of the weak verbs no vowel *i* in the ending and could, therefore, not change the stem vowel in the singular present. The English preterit *went* is German *wendete;* the participle *gone* comes from the short stem retained in a still shorter form in modern *ago*. The verb *stehen* ought to go in German: *standen, stehen, stund, gestanden*, in English *stand, stood, stand*. The infinitive *standen* surviving in South German dialects is superseded by the stem *stehen* in the literary language. *Stund* is the regular form in Goethe's Götz; *stunden* occurs in Goethe's Werther: *Die Augen stunden ihm voll Thränen*, also in Schiller, *e. g.*, *stund er noch an sich zu erklären*. *U* is further found in the subjunctive *stünde*. *Stand* crowded in from the participle under the influence of such forms as *band—bunden, fand—funden;* in English, the reverse has taken place the vowel of the preterit having been generalized.

In speaking of the endings of the verb it is well to remember that German as well as English *e* in unaccented syllables does not represent the full vowel but expresses a slurred obscure sound. It may have resulted from any one of the vowels (cf. English *beggar, copper, zephyr, camphor, sulphur*). In the second and third singular present indicative of the strong conjugation its prototype was *i;* the Old High German forms of *tragen* were *tragu, tragis, tragit*. This *i* caused the umlaut and in case the stem-vowel was *e*, this *e* was changed to *i* (*brechen, brichst, bricht*). The old forms *fleugst, fleugt* as compared with *fliegen* have to be explained in the same way. In the weak conjugation the same vowel followed the stem in all persons, therefore the latter cannot vary (cf. Old High German *salbōm, salbōs, salbōt*). If a strong verb has become partially weak, the vowel of the infinitive may remain (*du backst, er ladet* by the side of *bäckst, lädt*); if a weak verb shows strong by-forms, umlaut may appear (*fragst, frägt*). In the old preterit subjunctive the ending was likewise *i*, therefore, modern German *trüge*. Umlaut also explains the class of the so-called *rückumlautende* weak verbs which formed their preterits without a connecting vowel. *Brannjan—branta* had to give *brennen—brannte; taljan, tellan—talde, tell—told*. The vowel of the preterit, then, is here the original vowel, the *e* of the present its umlaut.

As the strong verb expresses the idea of the past by an internal change, the first and third singular preterit indicative have always been

without endings. This accounts for the uninflected *ich*, *er*, *kann*, *I*, *he*, *may*, etc., *ich*, *er*, *weisz*, *I*, *he dare*. In *he need* an ending was dropped. *Wurde*, so frequently used as auxiliary, owes its *e* to a confusion with the weak conjugation. It is the only remnant of a long list of contaminated forms of the early Modern High German period (*sahe*, *schalte*, *schwiege*, *sotte*, *sprange*, etc.) that has left frequent traces in the classical literature. English *shalt*, *wilt*, correspond to Middle High German *solt*, *darft*, which latter *t*-forms are still quite frequent in Herder.

The Germanic past participle had as the Gothic shows, originally no prefix. But the older idioms possessed a number of compounds with the prefix *ge* which often expressed completed activity. Naturally then the compound forms were chiefly used in the past participle and gradually became characteristic of it. Their use predominated over the short participle in Anglo-Saxon, many *y*-participles (into which they developed) may still be found in Shakespeare and Milton; in Byron occur *yclad* and *ygazed.* In German the *ge*-participle has been the rule. Exceptions are 1) those verbs that are already compounded with an inseparable prefix, 2) the foreign verbs in *ieren* which were framed under French influence; 3) the auxiliary *werden*; 4) old participles that survived as adjectives such as *rechtschaffen*, *trunken*; 5) the Low German verb; 6) South German dialects whenever the verb begins with an explosive. After the dropping of the *e* of the prefix, *g* was assimilated to the first consonant of the stem: *geklungen*, *g'klunge*, *klunge*. These contractions are not unknown to our poets: *Das Werk zuletzt ist doch vollendet blieben* (Goethe), *Hamster hat mich bissen* (Uhland), *der Vater ist gangen, die Wölfe zu schiessen* (idem), *Bist du hierher kommen* (Schiller), *Still ist schon das ganze Darf, alles schlafen gangen* (Lenau); 7) such contractions as *ich habe arbeiten können*, *lassen* where now owing to the lack of the prefix, the form appears to us as the infinitive. In *ich habe arbeiten hören*, *i. e.*, whenever a weak verb occurs, we have a case of analogy. Information on this or similar points may be found in *Behaghel's Deutsche Sprache*, *volume 54* of the popularly written *Wissen der Gegenwart*, *Deutsche Universalbibliothek für Gebildete. Leipzig. G. Freytag.*

In discussing our subject, I have so far endeavored to show why it is good policy for a teacher of German in this country to present his subject in the light of a language cognate to the English. We were naturally led to the older periods in both, because cognate languages must necessarily resemble each other more and more the nearer they approach their common source. The knowledge of the historical

development of a language does, however, not only facilitate comparison between kindred idioms, it also ensures to its student a fuller and better understanding of its present form and meaning. To illustrate this briefly, I will mention in conclusion some metaphorical expressions many of which reveal their full significance only to him who has traced their origin. *Zum Kuckuk, geh zum Kuckuk, der Kuckuk mag es wissen, der Kuckuk hole ihn, des Kuckuks werden*, etc. The cuckoo was considered by the old Germans to be a prophetic bird. After their conversion to Christianity which changed all the gods of heathendom into demons, it became the bird of the Evil One and Kuckuk was often used directly for *Teufel. Bei einem etwas auf dem Kerbholz haben.* The tally was a stick on which incurred liabilities were marked by means of cuts. The usual way of proceeding was this. A stick about one foot long was cleft into two narrow sticks which of course would fit exactly into one another. The one stick was taken by the creditor, the other by the debtor. Each time a new debt was incurred the two sticks were joined together and marked by a new horizontal line which was cut into both. *Jemand einen Korb geben, einen Korb bekommen, sich einen Korb holen.* The lover used to be hauled up in a basket to the window of his lady. In case he was not welcome, she dropped the basket or arranged so that it should break. In the more civilized seventeenth and eighteenth centuries the progress was simplified, the cold maiden saved her lover the trouble of the fall by sending him a bottomless basket in reply to his declaration. The custom still exists in a somewhat modified form in some rural districts of South Germany. *Stein und Bein schwören.* If a person in the Middle Ages had to swear an especially solemn oath, he was taken to the church and there swore by *Stein* and *Bein*. The *Stein* was the altar, the *Bein* the relics, the bones of the Saints. *Einen bei den Schlafittchen kriegen. Schlafittchen* is a corruption of the *Schlagfittiche*, the pinions of birds. *Sein Schäfchen ins Trockene bringen.* The fisherman of the German ocean calls his fishing smack, which at the approach of winter he beaches and pulls under a shed for shelter, *Schepken* (*Schiffchen*). The Low German term being misunderstood in the interior of the country became *Schäfchen.* Often a single word conveys as much as a whole sentence. The *Prügeliunge* was a creation of the old pedagogy. If young princes or noblemen deserved some corporal punishment, it was inflicted in their presence and for their benefit upon some boy who had been formally appointed for this office. He was their *Prügeljunge.* Such were kept *e. g.*, for King James II. and Charles II. of England in their youth.

What is the meaning of *Schranze?* In Middle High German it meant, *cleft*, *rift*, then *a slashed garment*, then *a young man with slashed sleeves, an overdressed young man, a fop, a parasite.* The word *Zapfenstreich* originated in the camps of the Thirty Years' War. To somewhat check the revelry and riotous living of the soldiery, the sutlers every night upon a given signal had to drive the plugs into the wine and beer barrels. To prevent the unlawful reopening of the same, the provost made the rounds of the camp drawing a red pencil mark over barrel and plug. This is the *Zapfenstreich*, Hollandish *taptoe* (*i. e., Zapfen zu*), English *tattoo.* The German *Elend* is a compound of *eli* (Latin *alius*) and *Land*, meaning *foreign land, exile.* Thus living abroad and living in misery were identical to the Old German mind. A present was called an *Angebinde*, because it was actually tied to the child's neck or arm on its birthday. *Schlaraffen* have been known since Hans Sachs who discovered *Schlauraffenland. Schlaur* is the Low German *sluren* (*to scuff*), a *Schlaraffe* is thus originally a person too lazy even to lift up his feet in walking. Numerous instances of this sort and their explanations are contained in the following two collections: *W. Borchardt, Die sprichwörtlichen Redensarten im deutschen Volksmund, nach Sinn und Ursprung erläutert, Leipzig 1888; Dr. Hermann Schrader, Der Bilderschmuck der deutschen Sprache, Weimar, 1896.*

"The Literary Side of the Question," Assistant Professor Von Klenze:

It is a fact that the study of German texts chosen even from the masterpieces of German literature only in rare cases quickens the literary insight of students. The fault lies only partially with the student himself. Often teachers have not attempted to train themselves in literary appreciation, and do little to interpret the text as a work of art. In order to remedy such difficulty it is imperative that all those whose province it is to teach literature, no matter in how simple a form, should acquaint themselves with some of the best literary work of the world. But it is not enough to appreciate the literary value of the text in hand in order to convey to the student its full significance. Even simple texts, as for instance certain Lyrics of Goethe, particularly however some of the dramas of the classical German period, cannot be understood with all the thoroughness which may be expected in modern times without some appreciation of the background, of the times which produced them. Schiller's "William Tell" becomes more intelligible

and more interesting when the student becomes aware of Schiller's intellectual development, when the desire for liberty which pervaded the times, when the American Revolution and the French Revolution are brought into relations with the play.

The average teacher, over-worked as he is, finds little time for studies of this kind, carried on on a large scale. But it is possible for everyone to do something in order to prevent the text from remaining a mere collection of examples to illustrate grammatical rules.

## THE CONFERENCE IN GREEK AND LATIN

ASSOCIATE PROFESSOR F. J. MILLER, Chairman

The first paper presented was by Professor H. W. Johnston, of the University of Indiana, upon the subject, "The Teaching of Second-Year Latin." The paper follows:

Reports from the high schools of Indiana show that the work of the second year in Latin is very generally disappointing to the teachers. The work of the first year is made irksome by the presence in the classes of many pupils who, for various reasons, ought not to study Latin at all, but must try the work because it is by actual trial only that the fit can be distinguished from the unfit. By the end of the year, however, most of these incapables have been discovered and removed, and the second-year classes ought to start, and, as a rule, do start, with pupils only whose records show that they are able to learn Latin and whose presence shows that they want to learn it. They are, therefore, a picked lot, and the year ought to be one of pleasure and profit to the teacher and the taught. As a matter of fact, almost as large a percentage of failures is recorded for the second year as for the first, and the Hoosier schoolmaster is anxious to know why. His being a Hoosier schoolmaster makes him all the more anxious and eager to find the cause. People are not bound by traditions in our state. Parents do not make their children study a given subject just because they studied it themselves, and their fathers before them. If the Hoosier schoolmaster cannot make the study of Latin show results commensurate with the time and effort it takes, he must expect to see his classes deserted for the history, German, or science that may be taken instead. We do not have even the fetish of the bachelor of arts degree to keep our Latin classes full. In the State University, for example, only about one fourth of the candidates for the bachelor of

arts degree who entered this fall are taking Latin, and of these any may discontinue the study at the end of a single term.

This being the state of affairs, we have done our best to discover the cause of the failures in the second year, because the trouble seems to go no farther: pupils once in the third year are almost certain to finish the course successfully and happily. We have looked in every direction for counsel and help. Wherever a prophet has lifted up his voice we have hearkened diligently. A prophet told us that our teachers lacked preparation. We have put our Latin classes in almost all our schools into the hands of graduates of colleges, in most cases the teachers being what we call specialists, but the trouble is not removed. A prophet told us, and I want to get his exact words, that the "difficulty is inherent and inseparable from the transition from detached and isolated sentences to continuous narrative." That did not help us much. Continuous narrative ought to be easier than detached and isolated sentences, and we believe in getting into it as soon as possible. It would be better if we started in it. A prophet told us that Cæsar was too hard for second-year work. We substituted Nepos, and Eutropius, and *Viri Romæ*, and all sorts of things, only to find that while the death rate of the second year was lowered, that of the four years was as high as before, and the survivors lacked in many cases the vigorous constitutions their predecessors had had. These last few years I have been doing a little prophesying myself, and it is to this voice crying in the wilderness, the wilderness of Indiana, that you are now invited to listen, because it is believed the conditions in adjacent states are not essentially different from our own.

Some time ago I stood at the door by which a crowd of second-year students was entering a high school, and at my request the principal stopped about a score of bright-looking boys and girls long enough to put two questions to each of them. The first was: "Do you know your algebra lesson this morning?" The answer in every case was a decided "Yes, sir," or "No, sir." The second question was: "Do you know your Latin lesson this morning?" We did not get a ringing "Yes, sir," from a single pupil; even the best of the lot, those who made creditable records in their Cæsar, when they recited a few minutes later, ventured nothing more decided than "I hope so," or "I think so." The principal did not need to sit with me, as he did, through the recitations of three sections of that Cæsar class to find out the trouble. The algebra lesson was a fixed and definite thing. Every pupil knew before he entered the recitation room just

about what questions would be asked, and he knew, of course, whether or not he could answer them. No boy could guess what he was to be asked in his Latin class, and his preparation was therefore vague and necessarily unsatisfactory to him.

Perhaps it is worth while to describe the three recitations that I heard. The lesson was the same in all, and in all the first thing done was the translating of the text in the ordinary way. After each student had translated the part that had fallen to him, the teacher asked questions suggested by it. In the first section the moods and tenses made the important thing. Not a verb was passed unnoticed, and the last had hardly been satisfactorily done when the bell rang and the class was dismissed with the brief direction: "Take the next fifteen lines." In the second section the verbs escaped, but the cases were made the subject of the closest possible scrutiny; every ablative and dative, and so on, was explained and labeled as the moods had been before. I remember that one little girl cried because she could not explain, or rather name, the use of *moribus* in chapter IV of the first book, though she knew it was an ablative and had translated it correctly. I suppose she was naturally dull. I forgot the name myself before I got home and took the trouble to look it up; one grammar called it the ablative of attendant circumstances, another the ablative of cause, another the ablative of specification, another the ablative absolute. I am waiting with interest for the coming of the great grammar, in order to find out for certain what the little dunce was crying about. The third section spent most of its time on the same word, *moribus*, but the word was made the text for a very interesting and profitable exposition of the Keltic administration of justice. These two sections were also directed to take the next fifteen lines. Don't you think the boy was in hard luck who had got his cases up in good shape that day and found himself in the section that was doing verbs? Do you think there was as much variety in the recitations of the three sections, if there were three sections, of that algebra class?

It is probably unnecessary now for me to say that, in my opinion, the trouble with the work of the second year is not due to the difficulties "inherent in and inseparable from the transition from detached and isolated sentences to continuous narrative," or to the lack of preparation and training on the part of the teacher, or to the particular author taught. It is due, nine-tenths of it at least, to the failure of the teacher to so assign the lessons and conduct the recitations that the pupil may make adequate preparation for them, or, in other words,

to hazy, indefinite, and shifting methods of teaching. I anticipate two objections. It is contended that mathematics and language are essentially unlike, and that the instruction in the latter cannot be made so definite and precise as in the former. I admit the difference between the subjects, but I shall try to show that, so far as concerns the second year, the teaching of Latin may be made practically as positive and direct as that of algebra. It is also contended that the work is definite now, that all the matters covered in the three sections that I heard recite are properly connected with a study of Cæsar; that the class must understand the uses of moods, tenses, and cases, must be made familiar with Gallic customs, and British and German and Roman also, in order to understand the story that Cæsar is telling. I admit this, too, but I insist that these matters are not of equal importance, that some must be passed over very lightly at first, that others may be postponed indefinitely without serious interference with the work of the year. I learned long ago that the golden rule of all good teaching is: Never do today what you can postpone until tomorrow. Let me show you how I would teach Cæsar or whatever author is studied in the second year. I shall call the subject Cæsar, for short.

At the outset I should take one of the matters mentioned above and give it first place. I should not merely give it first place in my own mind, but I should tell the class plainly that it is the all-important thing, and that any pupil who prepares that thing well from day to day may feel sure that he is doing his work satisfactorily to me, if all else is left undone. For many reasons, that I cannot stop to give, much less to discuss, I should make translation that all-important thing. One reason I must give. My freshmen, as a general thing, give me poor translations of even those passages that they understand thoroughly. Almost all of them have acquired a stock of words that they never think of using anywhere except in the Latin room; they employ idioms that they know are not English, and they have the habit so firmly fixed that I never succeed in thoroughly breaking it. Of course you all know what this translation jargon is, but I cannot resist the temptation to read you a little skit that is said to have originated with Professor Lane, of Harvard, himself a model in the matter of translation, though I imagine it has been greatly changed from its original form in the process of oral tradition:

*Concerning a youth who was unable to lie*

A certain father of a family to whom there was a sufficiently large farm, moreover a son in whom he especially rejoiced, gave this one for a gift on his

birthday a little ax. He exhorted him greatly to use the weapon with the highest care, lest it might be for a detriment to himself. The youth promised that he would be about to obey him.

When it was necessary for that one, on account of business, to seek a certain walled town situated not far, this one, the ax having been hastily seized, departs into the garden, about to cut down each most flourishing cherry tree.

That one, his home having been resought, inflamed with wrath, the servants being called together, asked who might have been the author of this so great slaughter. All were denying, when this one, running up to that one, "Truly, by Hercules," said he, "O my father, I am unable to lie; I, myself, cut down the tree with that little ax which thou gavest to me for a present."

The fault is due, in most cases, to simple carelessness on the part of the teacher; in a few cases to the effort to prevent the use of printed translations by insisting upon a so-called literal translation; in less degree to the confusion between reading Latin in its own order and translating it in that order. Every teacher ought to know, of course, that there is no such thing as a literal translation. The very phrase is a contradiction in terms. Every teacher ought to know, too, that a person who can read Latin in its order never thinks of English words at all as he reads it, and could not translate it as he goes along, even if he would.

But what is a good translation? I will give you my definition of the sort of translation that I should insist upon as the essential thing in the second year's work. A good translation is one that gives the exact meaning of the original in sound, idiomatic English, in such a way that the average pupil in the translator's class, having the Latin text before him, can trace each word or phrase in the translation to its source in the text. Next, how are we to get these translations in the class? I should make the review lesson the test of the translation, and should insist upon its being read off correctly and fluently in as little time as so much English would require. I expect the pupil to blunder in his translation of the advance, and I tell him so, but there must be no blundering, no hesitating, no repeating in his translation of the review. This fluent reading of the review can be secured easily, you will be surprised to find how easily, if the teacher treats the advance properly. Too many content themselves with interjecting corrections or improvements into the student's translation as he goes stumbling along. The objection to this is that it confuses the pupil who is reciting, and that it is impossible in nine cases out of ten for the class to put the boy's version and the teacher's suggestions together in such a way as to make them fit. A better way, because

less confusing, is to let the pupil give his own version, however faulty it may be, and then to criticise his rendering of the passage, commending what you can, amending what you must, and finally giving a coherent translation of the whole passage, free from all comments and explanations. When the entire lesson has been read in this way by the pupils and teacher, the teacher should read it all off to the class in the best English he can command and then insist that the review of the lesson the next day be as fluent and as smooth as his own rendering has been. I should make it a rule never to let the class leave the lesson until I had read it off in my very best style at least twice, and I should always be ready to read it again and again if asked to do so by any member of the class. I also urge my class to read their translation of the review over out loud before they come to the recitation room. If you teach translation in this way it will be a very definite thing to your pupils.

In the second place, but second with a great interval between, I should put the teaching of syntax. I think too many teachers do the grammar work, as we call it in Indiana, as it was done in the recitation that I have described. That is, when the pupil has translated his part of the text the teacher puts to him such questions on the syntax of the passage as are suggested by the text itself or the faults of the translation. I have three objections to this method, prevalent as it is. In the first place it interrupts the exercise of translation, which I think of greater importance, and distracts the attention of the class. In the second place such questioning is very apt to run in ruts, to become one-sided. I had a teacher once who always asked about ablatives of specification and subjunctives of characteristic, and when I was sure whether the word in question was noun or verb I always gave the right answer. In the third place it is hardly fair to expect the pupil to answer without warning the one thousand and one questions which may be put on any chapter of Caesar by a capable cross-examiner. To this method, as I have hinted already, I charge the positive aversion felt for Latin by many good but slow students. They are not so questioned in any other recitations. It was not good pedagogy, as I look at it, to make that little girl cry. The right way is to let the pupil know in advance just what questions you are going to ask him and give him a chance to look them up. I should do this by insisting that the class learn the notes on the day's lesson as thoroughly and as conscientiously as they translate the text. Then, when the translation has been finished in the way I have described, I should call up the next

boy and proceed to ask all the questions answered in the notes and absolutely no others.

But, suppose the notes pass over important points of syntax unmentioned, or the pupil's translation shows that he mistook the construction of certain words? That gives you your chance to do a little teaching in the form of declaratory sentences, sentences that are all too rare in second year teaching. Quietly call attention to the word and explain its use in the simplest way you can. Or, if you are wedded to the interrogation mark, save up these matters till you are done with questioning particular pupils on the notes, and then have a little general exercise, letting any one answer who can. This will be a safety valve for the smart pupil who likes to show off, and is often a pleasant change for everybody. This guards against one-sided questioning, against unfair questioning, and, taught in this way, the grammar work becomes as definite and precise a thing as a geography or algebra lesson.

The composition that always forms a part of the work of the second year should be made to serve two purposes in connection with the grammar work. For four days in the week it should follow closely the notes on the daily lesson, the teacher dictating to the class a few short and easy sentences that will fix in the pupil's mind the principles to which his attention is called in the notes. If the teacher lacks time to prepare sentences of his own he may easily select them from one or more of the many manuals based upon the Gallic war. The important thing to remember is that the sentences in most of these manuals are too hard, those intended for *viva voce* work being difficult enough for written exercises. For the fifth day the recitation may very well be devoted to such a systematic study of syntax, independent of the text, of course, as is given in any of the "old-fashioned" composition books, Jones's for example. In connection with this lesson I should urge a careful review of the declensions and conjugations; for this purpose I know of no plan so good as that followed by Comstock in the "General Questions and Practice" in his *First Latin Book*. I wish they could be printed off separately.

The other things that "go with Caesar" are, in my eyes, relatively so unimportant that I may pass them over very briefly in this discussion. Of course you must do something with the antiquities of the subject, but don't go in too deep. To understand Caesar's battles a boy must know something of the Roman art of war, but not nearly so much as most of our text-books tell him. You and I know very little

of naval tactics, but I imagine we read the story of the battle of Manila clear through without stopping to consult the dictionary or the encyclopædia. It is preposterous to worry second-year students with the order of promotion of the centurions in a Roman legion, or the calculation of the cubic feet of soil that a private soldier could get out of a ten-foot ditch with a wooden spade while a left-handed Gaul was slinging stones at him from the top of a ninety-foot wall. I should let such things take care of themselves. I don't want to make generals out of my boys; they are strenuous enough as they are.

Sight reading ? Yes, by all means, if you have any time left after doing the other things. Select the sentences from the next day's lesson always. In this way you will get the undivided attention of the whole class as well as of the boy who is reciting, and the going over the matter the next day in the regular order of things will insure the accurate rendering of the passage. Let it be distinctly understood, however, that no pupil's class standing is going to be raised or lowered by sight translation in the second year, and remember that ten minutes practice in taking a sentence one word at a time by Professor Hale's method is worth half an hour of ordinary sight reading.

Finally, let me sum up what I have been trying to say: Make the assignment of work absolutely definite, so precise that the pupil may anticipate every question you ask. Preserve the emphasis throughout the year; don't shift it from term to term, much less from week to week or from day to day. Make good English translations the important thing. See that your own are good to start with, then lay stress on the translation of the review only, and you will do more than can be done in any other way to prevent your students from resorting to the coward's aid, a printed translation. Don't make a little tin god of the word "thoroughness": leave something for the pupil to learn the next day. Be thankful that he translates an ablative correctly even if he can't name it; you cannot name the first hundred ablatives in Cæsar the same way twice in succession, and neither could Cæsar. Lastly, don't make the little girl cry.

Assistant Professor W. B. Owen then read a paper upon "Some Recent Discussions on the Teaching of Greek and Latin in Secondary Schools." This was followed by Professor Capps upon the "Dependence of Greek upon Latin in the Secondary Schools."

The following topics were brought before the conference for

preliminary discussion, and committees were appointed to report at length upon these topics at the next conference.

(*a*) How can a larger knowledge of the ancient classical literature be insured to students in secondary school and college?

Committee: H. N. Herrick, the Robert Waller High School, chairman; Katharine Jones, the Hyde Park High School; Carolyn Parrish, the Lake View High School; Fannie R. Smith, the South Division High School; George H. Rockwood, the Austin High School; E. J. Kelsey, the Elgin High School; Katharine Reynolds, the West Aurora High School.

(*b*) Current literature and events of interest to classical teachers in secondary schools.

Committee: W. B. Owen, chairman; I. B. Burgess, Morgan Park Academy; Gertrude P. Dingee, the Hyde Park High School; Walter Comstock, the Englewood High School; H. F. Scott, the Indianapolis High School.

## THE DEPARTMENTAL CONFERENCE IN HISTORY

R. C. H. CATTERALL, Chairman

Dr. J. W. Thompson read the report of the committee "to rearrange and adjust courses 1, 2, and 3 so as to make them conform as far as possible to the courses prescribed by the Committee of Seven, and also to the courses recently adopted by the best American universities and colleges."

The present requirements of the university are as follows:

1. The history of Greece to the death of Alexander.
2. The history of Rome to the death of Augustus.

The above examinations call for general information on the facts of Greek and Roman history, and a more detailed treatment is also required of one topic, chosen by the candidate from a selected list.

In the report of the Committee of Seven, ancient history is defined as preëminently that of Greece and Rome, but including also a short introductory study of the more ancient nations. In the history of Rome that of the early Middle Ages is embraced.

Mediæval and modern European history is defined as the record of human affairs "from the close of the first period (*i. e.*, ancient history) to the present time."

The general recommendation of the Committee of Seven is as follows:

(*a*) For the classical course, one unit[1] of history, to consist of one of the four blocks[2] suggested.

(*b*) For the Latin course, the same.

(*c*) For the scientific course, two units, consisting of any two blocks.

(*d*) For the English course three units, consisting of any three of the blocks, or of two blocks and a combination of two others.

In discussing the matter the committee found two separate questions to consider.

First, the question of policy with regard to requirements: should the student be allowed a liberal option in choosing the field of work, the committee fixing the *number* of units, *not the subject* of the units.

Second, should the committee adhere to the present university view of what constitutes ancient history and general European history, or should it accept or modify the recommendations of the Committee of Seven.

The committee is of the opinion that it is advisable to adhere to the present exaction of classical history for all entering students, even in the case of bachelor of science and bachelor of philosophy students, as specified on page 55 of the *Annual Register*, 1900–1. The committee recommends, however, a broader definition of ancient history than that adopted by the University of Chicago, and one more in keeping with the report of the Committee of Seven.

The Committee of Seven defines ancient history as that of Greece to 146 B.C., and of Rome to 800, but including also "a short introductory study of the more ancient nations." In this light the present university requirement of Greek history to the death of Alexander and Roman history to the death of Augustus, is lamentably deficient as a survey of the classical period, and yet more defective, owing to its entire omission of the ancient Orient. The Hellenistic period of Greek history is ignored, save as it becomes a side-feature of Roman history, and the most authentic and valuable history of Rome (that of the empire) is omitted entirely.

It may be answered that there are two practical objections to the suggestion to extend Greek history back into the Orient, and Roman history down to the barbarian migrations:

1. Inability to cover the field in the time allowed.
2. The difficulty of procuring a suitable text-book.

[1] The term "unit" is defined as either one year of historical work during five hours per week, or two years of historical work during three hours per week.

[2] These four blocks are (1) ancient history, (2) mediæval and modern Europe, (3) English history, (4) American history and civil government.

The committee is of opinion, however, that time may be saved by abolishing the present practice of "special topics," and this is recommended. Moreover, the difficulty of securing suitable text-books which has hitherto been a serious one, seems now likely to be relieved.

In view of these considerations, therefore, the committee is opinion that the teaching of ancient history shall hereafter be made to include some knowledge of the old East, and be extended to 337 A. D.[1] We believe that with the abandonment of the special topic feature and the use of a good text-book, it will be practicable to extend the course to this point.

With reference to Courses 3*a* and 3*b*, the committee recommend that the alphabetical distinctions be abolished, and that in the future the subject be taught as a whole, no half-unit being allowed. This will entail some modification of the classification given to ancient history. The committee recommends that hereafter the unit of number indicate the unit of work, and that ancient history be designated as Course 1, to be differentiated into 1*a*, Greek history, and 1*b*, Roman history, a half-unit credit being permitted in these two cases only; as for 3*a* and 3*b*, that in future it be designated as Course 2.

The conference accepted the recommendations of the committee to abolish "special topics;" to extend the study of ancient history to 337 A. D.; to accept for entrance credit Greek and Roman history as modified by the report; to abolish the division between mediæval and modern history, and to count 3*a* and 3*b* as one unit.

Mr. Catterall submitted the report of the committee to consider the advisability of substituting some other arrangement for the present courses 4*a* and 4*b*, 5*a* and 5*b*, and to recommend text-books for use in these courses:

Without recommending, they suggest the following plan in reference to the courses mentioned: That 4*b* be so arranged that the student may offer work done on the periods 1492–1783, or 1783–1897; or the present requirement, for a unit's credit. In regard to 5*b* that the student may offer courses covering the periods 455–1485, or 1485–1900, or the present requirement for a unit's credit.

[1] This recommendation will cover *Botsford's Rome*, chaps. I–XII, and XV. Chap. XIII, The Divisions of the Barbarians. Chap. XIV, "The New German States and the Empire of Charlemagne" will constitute the beginning of Course I in the University of Chicago, but it is yet within the option of teachers to cover the entire book and their students will probably do more satisfactory advanced work in consequence.

In regard to text-books, a number were named as being excellent, but no positive recommendation was made.

The conference rejected the suggestion as to courses 4*b* and and 5*b*.

A committee was appointed to report at the next meeting on the question of teaching civics in a three years' course of history.

## THE DEPARTMENTAL CONFERENCE IN MATHEMATICS

ASSISTANT PROFESSOR SLAUGHT, Chairman

This was attended by about ninety people representing some sixty different schools, including a goodly delegation from the university. Heretofore, the papers and discussions have been entirely upon matters connected directly with the work of the preparatory schools ; but this time one of the papers dealt with the subject of modern geometry, quite independent of any direct application which might be made to the teacher's work in the schools. This paper by Professor Maschke, of the University, aroused much interest and enthusiasm.

The other paper, by Professor Myers, of the Department of Education, dealt with the teaching of secondary mathematics, and gave rise to active and prolonged discussion on the various propositions made. These papers in somewhat condensed form are given below:

### SOME MODERN METHODS AND PRINCIPLES OF GEOMETRY

I am to talk today about modern geometry. The time at my disposal is very brief and the subject-matter very great, and so I have only a few points which I can present to you, although I do not suppose that everything I shall say will be new or unknown to you. I have also to ask your pardon if I am not so exact and rigorous in my statements in this summary report as I ought to be. You will allow me statements of this character: "Bructerus mons omnes superat Herzyniae montes." This statement is all right for an ordinary human being, but not for a mathematician ; for the Bructerus (Brocken) is a mountain of the Harz, and the above statement would make it higher than itself.

It might be said for the most important parts of recent geometry that one conception dominates everywhere : that is the conception of

the *group*. Suppose we are given a set of operations of any kind, which I call $S_1$, $S_2$, $S_3$, $S_4$, . . . . .. finite or infinite in number — a set of operations which are defined by some law. Take now one of the operations, say $S_i$, apply it first, and after that has been done apply in succession another operation, $S_k$. If now it is so that the combined operation $S_iS_k$, which is obtained by applying first $S_i$ and $S_k$, is again an operation *in the original set;* and if this is so for any two operations of the set, then the set forms a *group*. Let me give you an example. Think of a sphere with center fixed, and define a set of operations by all the possible rotations of the sphere about its center. That is an infinite number of operations. These operations, I say, form a group. Revolve the sphere first about a certain diameter through a certain angle. This is one of the operations of our set. After that has been done, take another axis and revolve the sphere about this second axis through a certain angle. Then it can be proved that the combined effect of these two rotations is equivalent to a single rotation about a certain axis and through a certain angle. The effect produced by two operations of the set applied in succession is the same as the effect of another operation contained in the set. Therefore, all these rotations form a group. The number of operations in this group is infinite.

Suppose now we have a triangle with sides of two, three, and four feet in length. Whether we make an investigation about this triangle here in this room in Ryerson, or over in Cobb Hall, say, the result is the same. That means that in geometry we are independent in our investigations of the location of our figures in space. In other words, if I make a certain investigation of a certain triangle and then move that triangle to some other place in space, I do not change anything of the character of the theorem. Now, instead of saying that we will move our figure from onc place to another, I will rather say that we move the whole of space by that same amount which will bring this figure into coincidence with the other figure; and so then the following statement will be clear: that our geometrical theorems are not changed when we submit the whole of space to a certain motion. The truth of our geometrical theorems is independent of the motion of space. If we consider all the possible motions of the whole of space, then these motions form a group, because the application of two motions in succession is equivalent to one single motion. Every motion can be considered as a transformation in the following sense: Suppose we take a point, and fix it by some means, say by its coördinates x, y, z; then by any motion of the space the point (x, y, z) goes

into another point (say $x'$, $y'$, $z'$); and so every point of space is *transformed* into some other point, and what we consider is this transformation, the connection between the points in the old position and the new position. Now, whenever the notion of a group comes in there is always the question of what remains invariant under such a group. If we subject the space to all possible motions, the most important invariant is the distance between two points. Take any two points, A and B; however you may move your space by translation, or rotation, or whatever you like, the distance between A and B remains always the same: it is an invariant. Also the angle between any two lines is invariant under this group of all possible motions in space. Of course these are not the only invariants. Indeed, every geometrical property—the theorem that the three perpendiculars at the middle points of the three sides of a triangle meet in a point, and all similar theorems—is independent of the accidental location of the triangle in space; all these theorems have an invariant character.

Let us go a step further. Take some triangle, ABC, and consider the symmetrical triangle $A'B'C'$—all sides and angles equal respectively, but lying in the opposite direction. It is possible to make them lie one on the other by a certain motion. Take the line of symmetry, and revolve the plane of the first triangle about this line; then this triangle will cover the other one. But such a motion is not possible if you allow only motion in the plane. Let us say the triangle $A'B'C'$ is obtained from ABC by a *reflection* on their line of symmetry. In space, take a certain plane and reflect our figures on this plane. An irregular tetrahedron goes by such a reflection into another precisely equal to the first; but it is not possible by any *motion* in space to bring the two tetrahedrons into coincidence with each other. It is like the difference between the right and left hands. It would be possible to bring them together by mere motion if we could go into a space of four dimensions, but it is not possible in space of three dimensions; just as in the case of the two triangles, where it is not possible to bring them into coincidence by motion in a plane, but only by motion in space of three dimensions.

But now I say in our geometrical investigations it does not make any difference whether we consider a certain figure or a figure which is deduced from the first one by such a reflection.

Let us consider all possible reflections in space on all possible planes. The question is, do they form a group? The answer is, no, because one reflection on one plane changes a given tetrahedron into

a symmetrical tetrahedron, and any other reflection on a second plane changes the second tetrahedron into its symmetrical tetrahedron, which is equal and equally directed to the first, so that by two successive reflections we do not get again a reflection, but something which is equivalent to a motion. If, however, we join to all possible motions of space all possible reflections, this totality again forms a group, because no matter how you combine any motions and reflections, you always get either a motion or a reflection: that is to say, you get again an operation of the set. What is invariant under this group? The distance between any two points, the angle between any two lines, and in the third place, every elementary geometrical theorem.

Again let us go a step further. Suppose we investigate a triangle with sides respectively two, three, and four feet in length. A teacher in Paris does not say *feet*, but twenty, thirty, forty centimeters—a different size; but the theorems which he deduces from his triangle are the same as the theorems which we deduce. In other words, for our elementary geometrical theorems the size is immaterial. We allow then an expansion or reduction in size, everything remaining similar, of course. To fix the ideas let us define such an expansion or reduction in this way: Take a fixed point, first, and join it to all points in space by lines called radii vectores, and change every radius vector, without changing the angles, in the ratio $1:n$; the effect will be the expansion or reduction of the whole of space in size. Now let us join to all operations of our group containing all possible motions and reflections all these expansions and reductions; the combined operations form again a group, and this group has been called by Klein the *principal group* of geometry. Our geometical theorems then remain true under this principal group: that is to say, they remain true if we apply any one of the operations of this principal group—any motion, any reflection, or any expansion or reduction in size.

If we ask about invariants, we see at once that under this group the distance is not invariant. But the ratio of two distances is invariant; it remains, of course, invariant for every motion and every reflection, and also for every expansion or reduction. The angle between two lines is also an invariant under the principal group. With this conception of the principal group we might give the following definition of the subject-matter of elementary geometry. We might say it is the establishment and deduction of geometrical properties which remain unchanged under this principal group.

Let me now extend this group by joining other operations, and

then we come right into the middle of modern geometry. Take any plane figure in space, on the board, for instance, and now take a point not in the plane of the board, and join this point to all the points of your figure: let the point be your eye, say, and let the straight lines be the lines on which you look upon the different points. If now you take a plane and place that plane in any position between the point and the board, then we get what is called a projection of the figure on the board on this new plane. If A is a point in the plane of the board, and O your center of projection, then let the corresponding point in the second plane be A′, the point of intersection of the plane with OA; thus every point A goes into a definite point A′. How does this figure in the second plane differ from the figure in the first plane? Is the distance between two points preserved? Certainly not. Is the ratio of the distances of two points preserved? Certainly not in general. If you have the points A and B, and C in the middle, and project from the point O, the point C′ will *not* be in the middle of A′B′, unless the two planes are parallel. The angles between any two lines are also changed. But there is another thing which remains invariant — the ratio of two ratios. Take the line AB and divide it by C and D. Then

A C D B

$$\frac{CA}{CB} : \frac{DA}{DB}$$

is invariant under this projection. This is called the *double ratio* or *anharmonic ratio* between these points. Also this projection, however, might be considered as a transformation of the plane. Take the second plane and place it on the first plane; then you have on the first plane a certain point A and its corresponding point A′, B and its corresponding B′; so you have a transformation of the different points on that plane.

A similar transformation is possible in space; only to make that projection we have to take a point outside of space; that is, a point in the fourth dimension somewhere. From that point we project every point of our space into another three-dimensional space, and then bring that second space into coincidence with the first. Then you have the same thing — for every point A a new point A′.

Analytically this transformation is much simpler.

It can be shown that the coördinates $x'$, $y'$, $z'$ of the new points A′ are rational linear functions of the coördinates x, y, z of the old points A. From these formulas follows at once that all these transformations (they are called *projections* in the plane and *collineations* in pace) form again a *group*.

Apply to the x ′, etc., a collineation, and you get x ″, etc., in terms of x, y, z, a formula of the same kind. And every formula of that kind gives a collineation. Therefore the totality of all collineations in space forms a group. This group contains the principal group, because every motion, every reflection, and every expansion or reduction can always be expressed by a formula of the above kind. This is the group of projective geometry.

Here the distance is not any longer invariant, nor is the angle, nor is the ratio between two lines; but the double ratio is an invariant, indeed the most important one of this group of projective geometry. The subject-matter of projective geometry is then the study of geometrical theorems which remain unchanged under this group.

There are many other possible transformations of space, and each is defined by a certain group. I mention the Cremona transformation, in which the coördinates of the new points are no longer linear, but rational functions of the old, and the old of the new. These transformations also form a group, and that group contains all the groups which we had before. Another very general transformation is the transformation which underlies the so-called *analysis-situs* — the investigation of all those geometrical properties which remain unchanged for every continuous *deformation*. By that I mean any deformation which is so that two points which are very near together remain very near together; such a transformation as is made by squeezing a rubber ball in your hand. This transformation is so general, one might think, that by this process we could change any figure into almost any other figure. But by squeezing a ring you can never make a sphere, and conversely, by that prŏcess of deformation you can never get a ring from a sphere. There are also several invariants under this transformation — the most important of which is the so-called *genus*.

So much about these transformations of space. There is another principle of modern geometry which I wish to point out in a few words. I have mentioned occasionally before the *fourth dimension*. Now this new principle I am talking of is the free use of all kinds of dimensions in geometry. I wish to give you an example of that. You know that in geometry of three dimensions there are only five what are called *regular* bodies: the tetrahedron, the hexahedron, the octohedron, the dodekahedron, and the ikosahedron. If we wish to represent these regular figures of space in the plane, we take a plane and a point outside, and project, *e. g.*, the ikosahedron on the plane.

Several of the projected edges will meet. But that can be easily avoided in the following way: Place the body under consideration on the plane, and take as point of projection a point above the middle point of one of the faces and not far from it, in such a way that the upper face is so projected that it includes all the other faces. Then we can avoid any intersection of edges. (The thus obtained projections of the five regular bodies were drawn on the board.) If only these projections were given, from these projections we could draw conclusions on the regular bodies themselves.

Let us do the same thing in the higher space. Take the space of four dimensions. It can be shown that in this space there are six regular bodies. Our imagination fails of course to see them, but we can see the projections of these bodies into our space of three dimensions. Take a point in the space of four dimensions properly chosen so that no meeting of the different lines occur, and then we get a projection into our space of three dimensions.

A body of four dimensions is bounded first by what corresponds to faces in the body of three dimensions — *i. e.*, by a certain number of bodies of three dimensions, in such a way that all these different bodies lie in different spaces; and every one of these is bounded again by planes, every plane by edges, and every edge by vertices.

A set of models from the mathematical departmeut of the University of Chicago was shown in order to illustrate the projections of these regular four-dimensional bodies into space of three dimensions.

In reply to the question : "What is meant by geometry of four dimensions?" Professor Maschke said: Since we all are three-dimensional beings, it is utterly impossible for us to see in our imagination any space of higher than three dimensions. The study of higher spaces is therefore, and can only be, purely analytical. We might also treat analytic geometry of three dimensions in a purely analytical way, leaving aside all geometrical notions. In this sense analytic geometry of three dimensions is simply the study of functions of three independent variables x, y, z. This is, then, the answer to the above question: Analytic geometry of four dimensions is the study of functions of four independent variables x, y, z, w. But in this study we might borrow the phraseology from analytic geometry of three dimensions. We might talk of a plane, of a line, a point, a three-dimensional space in the space of four dimensions, meaning by these certain linear equations or systems of equations in x, y, z, w. One linear equation would represent a three-dimensional space, $w = 0$, for instance, the ordinary

space of three dimensions. Two linear equations in x, y, z, w would represent a plane, etc. Reasoning by analogy from three-dimensional space will help us then considerably in our analytic study in four dimensions.

In a certain way, however, also a direct geometrical insight into spaces of higher dimensions is possible. When we consider our ordinary space as consisting not — as we are accustomed to — of points as elements, but of straight lines, then it becomes at once a space of four dimensions, because a straight line is determined by four independent coördinals. And taking other simple figurations as elements of space, for instance, the sphere, the circle, the general surface of the second order, we might endow our ordinary space with any dimensions we please.

Professor G. W. Myers then read the following paper upon "Some Respects in which the Teaching of Elementary and Secondary Mathematics Needs Improvement:"

All persons having to do in an intimate way with mathematics are still pretty clearly divided as to their pedagogical views into mathematicians and mathematical teachers. The first class is not numerous; though it is made up of a very select and an extremely exclusive membership. On the contrary, the second class is very numerous, but neither so select nor so exclusive. While modern altruistic views of education would seem to require all mathematicians to be mathematical teachers, and while sound educational policy would seem to demand that all mathematical teachers should be in a sense at least mathematical investigators, still the writer has no disposition to criticise the reason for the existence of a rather sharply defined line of demarkation between two such classes. He would be understood to be merely stating a fact which anyone having the disposition can experience no difficulty in verifying.

Again, pursuant to the tendency of the mathematical mind to analyze and classify, we may subdivide the second class into three pretty well-defined schools. First, there are the mathematical teachers who look upon the question of the teaching of mathematics as fully answered in fixed and final form. Trace these teachers to their lair, and you nearly always find that finality has been reached through their own artificially prepared remedies in the form of some superficial methodology.

Then there are those who would have us think that a mastery of

subject-matter is a sufficient guarantee of professional efficiency in the mathematical teacher. If it were necessary to accept the alternative of identifying one's self with one or other of these two schools, the latter would be preferable. But fortunately there is still a third possibility.

There is among us a growing number of persons who occupy a middle ground between these two extreme positions. These persons distinguish between the doling out of popular catch-phrases and a sincere restudy of subject-matter, already familiar, with reference to the way in which the immature learner must proceed to its mastery. It is to this class of persons who believe in the possibility of improvement upon current mathematical teaching, persons who have both a mathematical outlook and inlook, who have both a prospect and a retrospect, that the remarks of this paper are addressed. To any others it would be useless to talk, for to him who sees no prospect of improvement, there is no possibility of improvement.

And now that I have defined my audience, I will proceed to the more specific purpose of this paper.

As to the mathematical work of the elementary school considerable must be said. I shall, however, discuss the changes to be desired in it only so far as they are organically connected with the work of the secondary school in mathematics. My remarks will accordingly be confined mainly to the improvements urgently needed in the last two grades of the secondary school.

Unless a stronger reason exists for the retention in the arithmetics of the long array of topics usually taught under the head of advanced arithmetic the following subjects, if well mastered are quite sufficient for the distinctive work of pure arithmetic: The four fundamental operations; the facts of the tables of denominate numbers, taught through using them in the teaching of the fundamental operations; common and decimal fractions and the principles needed for their use and reduction; G. C. D. and L. C. M. taught as a means of transforming and reducing fractions; percentage and simple interest. Good teachers can easily secure a thorough working knowledge of these foundation principles and operations, together with a considerable fund of geometrical ideas and no inconsiderable quantity of algebraic generalizations in less time than is now generally assigned to arithmetic. It is even maintained that this can be done without jeopardy to any of the other work of the grades by the end of the sixth school year. This leaves the seventh and eighth grades clear for

some serious work in elementary geometry and algebra and makes possible the completion of some things to such an extent that they need not be gone over again in the high school. Enough of these subjects could thus be taught to bring their more powerful methods of treating problems within the reach of the great numbers of pupils (fully 95 per cent. of those who enter school), who for reasons over which they have no control, can never hope to avail themselves of the advantages of the secondary school, much less of the university.

In all this elementary work I would have practical considerations the guide in selecting both matter and method. I would have the range and variety of subject-matter so great as to convince the pupil, whatever his tastes might be, that a mastery of the mathematics would be a powerful aid to him in reaching the ends in life which seem important to him. I would not hesitate to choose subject-matter whose importance consists in its utilities. I would not fear doing violence to that peculiar and fortunate mental attitude which predisposes the possessor to the pursuit of pure mathematics as a vocation, for I cannot conceive of the prospective specialist in pure mathematics loving his science any less because it is capable of a many-sided usefulness to many people whether they be prospective mathematicians or not. The contention that the elementary mathematics should be presented largely through its applications to problems which commend themselves to the pupil himself as being practical and valuable, is not, as some would have us believe, at odds with those who advocate the pursuit of a branch of science for its own sake and argue that pure mathematics ought to be studied with no view to its application. Those who take the latter view are far from claiming that all mathematics must be pure mathematics in the close technical sense. All admit that the surest progress in the pure mathematics is made by those who have laid for themselves a broad and stable foundation in the concrete world, for to this world they must frequently and for a long time return for illustrations and exemplifications to steady their steps through the abstractions of pure mathematics. As a matter of fact the habit of concreting an abstract problem is an excellent one for even an advanced mathematical student, since through its exercise he is able to lay firmer hold on abstract ideas. Vaguely conceived abstractions are weakening to the pupil, as they produce the pernicious habit of feeling satisfied with half-defined notions of things. Such habits may result in a sort of rosewatery intellectual mist, admirably adapted to the making of adult commentators upon what others have

done, where truth and intellectual honesty are qualities of secondary importance. But such habits are fundamentally at war with whatever makes for clear and forceful thinking without which substantial progress, both material and spiritual, is impossible for either the individual or the race.

Again, a good general caution to follow in mathematical teaching is never to allow a sharp line of demarcation to separate a subject from the subsequent subject for which it is to prepare the pupil. The roots of the new subject must be carefully buried in the soil of the old before the old is left behind. Frequent returns to the old for analogies and reasons for extensions of ideas must be kept up for a considerable time in the prosecution of the new study. Arithmetical work should not, therefore, be dropped abruptly and once for all at the close of the sixth grade. On the contrary, the seventh-grade work should be well-nigh altogether transitional between the previous and the subsequent mathematical work partaking somewhat of the character of both. The point to be borne in mind is that the seventh-grade work in arithmetic should lay the basis for elementary algebra and geometry, and should suggest the needs and means for teaching the more general methods of dealing with quantitative relations of things and phenomena. Elementary algebra and geometry should constitute the center of gravity of mathematical effort of the eighth grade, and the emphasis of attention of both teacher and pupil should be upon it. The arithmetic should be distinctly subordinate to these subjects.

The three lines of work must be so interwoven that the distinctive methods of each subject may appeal to the pupil as being merely different modes of dealing with the same subject-matter—merely different points of departure from which the same thing is to be done—the algebraic and geometrical modes growing out of the mental necessity of dealing with more comprehensive relationships than the limitations of the arithmetical mode will admit.

Problems should be drawn largely from science, mechanics, and the social industries, and should deal with real conditions. The reason for this is that the pupil should be led both *to sense* and *to see* the reality of the need of mathematical knowledge and skill in getting control of his environment. Geometrical drawing should find a place. The elementary notions of descriptive geometry ought to be included in the pre-secondary mathematical curriculum, and even the formal demonstration of propositions by the *quasi*-experimental method of

superposition should not be excluded, though only the beginnings of deductive reasoning should be attempted. Actual measurements from the surroundings and from the laboratories should be extensively used.

Money problems should be curtailed, to the end that the pupil may come to feel that there is much mathematics will aid him in doing besides making change and keeping accounts, neither of which ever has involved him in serious difficulty, nor is there any high degree of probability that they ever will. The thing most needful to the pupil to bring him to a point where financial questions are likely to assume a complicated aspect is a modicum of general good judgment; and the continuous treatment through the secondary school of artificial conditions and isolated problems do little toward the training of this prime mental attribute.

As to the work of the secondary school, much ought to be said of the manner and kind of improvement needed. Time limitations prohibit more than running suggestions. I believe the general introduction of what the English call Euclid into our secondary schools would be a monumental misfortune. Every argument against this sort of study of geometry which applies to English conditions — and their name is legion — holds with greater force under American conditions. But let us begin with an inventory of mathematical attainment, with which, under proper teaching, the pupil would enter upon his secondary work.

His work in geometry should have begun at an early stage. The writer does not believe the kindergarten is too early. He hastens to say, however, that most of his colleagues criticise this position; though there are few exceptions to the statement that the critics are generally hostile, most of them avowedly so, to any sort of mathematical work which necessitates the study of quantitative relationships as subject-matter of *special* thought. This draws some of the most painful shafts of the criticism.

Once begun, the geometry should be kept up — not necessarily on every tenth page of the text-book — to and through the eighth grade. Here it constitutes the bulk of the mathematical work. By the end of the grades a considerable knowledge of the uses of geometry should have been acquired, together with a degree of familiarity with geometrical figures, both plane and solid, and of their more useful properties and relations; a degree of intelligent skill in inductive reasoning, a working knowledge of similarity through the plotting to scale of field measurements with home-made and inexpensive apparatus; and

a fair understanding of the method of establishing equality by superposition of figures.

Under the foregoing plan, in algebra the pupil may be assumed to have a good idea of literal number; of the way literal number may be used to facilitate analysis, whether he is or is not concerned to know results in arithmetic numbers; of simple equations in one and two unknowns, together with some idea of how to use them advantageously in the solution of problems which would be difficult by arithmetic. He will have sensed, if not seen, that algebra proceeds along the line of generalizations from arithmetical number and processes, and that one of its great advantages consists in the possibility it affords of retracing the steps in an argument, or a computation so as to determine, at any stage in the solution, how a number has been obtained, whereas in arithmetic we "cover up our tracks" so that we lose sight of the origin and nature of our numbers. If the pupil has been trained from the first to translate his equations into verbal language, and *vice versa*, he will have learned to look upon the equation as the symbolic expression of a law of nature, or of number.

The writer does not believe it impossible to give the eighth-grade pupil a working notion of variable number, not in a didactic way, but through the graphical representation of simple equations, expressing laws of nature the meaning of which is within his easy comprehension, and to give some training in the interpretation of the graphs in terms of natural facts and phenomena. All of this means that teachers of mathematics should seek to give this subject a sociological aspect.

Up to this point the method of dealing with the pupil should be first to question the ideas into the pupil and then to question them out of him. So far as possible it is well to keep up at least the "illusion of discovery." The over-working of the pedagogical maxim, "Never tell the pupil anything," like many of its fellows, has, however, been made to do great injury to the pupil.

The teacher of secondary mathematics should avoid beginning his subjects, after the fashion of many of the texts, with a lengthy catalogue of the differences between the new study and what he has been studying in the grades. The essential unity rather than the accidental differences of the subjects should be impressed upon the beginner's mind, though not so much by precept as by example. One great advantage of this is that the pupil is not so terrified with the thought that the new subject is something wholly unlike anything with which he has hitherto had to do, so that he attacks the difficulties of the new

subject with a greater degree of confidence, feeling that his feet are planted on the firm ground of something he knows. Furthermore, what differences do exist should be shown to be of the nature of extensions of old and familiar processes to an extended realm of number concepts, first to the inclusion of negative numbers, then of irrational numbers, and finally of imaginary numbers. The analogous extensions of arithmetic processes, from positive integers to fractional numbers and to such irrationals as are met in the attempt to extract the square and cube root of imperfect squares and cubes, may be cited with great profit by a teacher who has an outlook, and let us hope that such teachers will rapidly become more plentifully available for secondary and elementary mathematical work. In the use of such ideas teachers of secondary mathematics particularly, if they be of the sort who have felt the "divine intoxication of learning," can communicate to their pupils the genuine spirit of mathematical study, and, after all, this is the important thing to impart.

It is believed that if geometry were taught as an outgrowth of some seven or eight of its trunk principles, much more satisfactory results could be secured than are reached by the common method of subdivision of its subject-matter into books with reference to the forms of the figures to be dealt with. For example, it is of decided advantage to the student to have learned from experience that when he has to establish the equality of any two figures, he may nearly always accomplish it by properly superposing them and noticing, or proving, that they coincide throughout. When this method of proof is mastered the mind of the learner has secured a point of view for attacking an extremely large class of demonstrations. Recourse is thus gained to a general method of procedure which deals successfully with about 20 per cent. of the proofs of plane and solid geometry. To keep the pupil in the dark unnecessarily, merely for the sake of having him struggle for the light which a mere intimation from the teacher might furnish, is to require the pupil to repeat in his own experience the experience of the race, as though the race had not had this experience. Such educational practice is reactionary. The ideas of economy of mental resource and of the greatest rapidity of progress consistent with stability, are ingrained in the Anglo-Saxon make-up, and to compel the American boy to keep swinging on the gate of elementary mathematical method after he is able to make pleasurable and profitable excursions into the higher fields, is to go far toward making him what the English call a "stale" man.

As a corollary to this principle, it is well to draw attention to the fact that the usual method of proving the equality of lines and angles is to make them parts of rectilinear figures and to apply the general method of superposition to these figures.

The propositions which relate to inequality should be gathered together and examined with a view to the discovery and statement of the organizing principle for establishing inequality.

A third principle is that involved in the measurement of angles whose sides and vertices have been brought into certain relations, as to position with reference to the circumference of a circle. This finds extended application in the study of the properties of lines and angles which may be brought into such relations to the segments of circles. A large class of cases depends upon this principle, and it is not difficult to generalize the principle from them, once they are gathered together under this point of view.

A fourth is the principle involved in establishing parallelism and similarity, which should be mastered so far as to meet the need of practicable applications without any reference to whether the parallel axiom is necessary, or tenable, or anything of the sort, and applied to a sufficiently great number of special cases to make the pupil appreciate its broad applicability to practice, and its general usefulness in both theory and practice.

The principle of the resolution of plane figures of all sorts into the triangle is well known by all to be of fundamental importance; but not more than half of the students who have completed the high-school course in geometry seem to get hold of it. Only a few weeks ago a mathematical teacher who has been in the harness for at least ten years asked me the surprising question: "What do you mean by saying the triangle is the fundamental plane figure?" This teacher soon betrayed the fact that she regarded the oblong, or rectangle, as the fundamental plane figure; I suppose because it ordinarily comes first in the chapter in arithmetics on mensuration. A sad commentary on the weaknesses of a teacher who has no outlook!

The principle of limits ranks high in the scale of importance among the central principles of geometry. I do not believe that more than one pupil in ten gets any adequate notion of this principle in the high school. If all the propositions depending upon it were gathered together and reviewed in the light of it, the principle would not be difficult. I do not agree with some that it should be postponed altogether until the university period. This would exclude a large

number of pupils from even a limited acquaintance with a very powerful method of dealing rationally with a large class of important problems.

The principle of analogy of two-dimension and three-dimension space relations may be invoked with great profit very early in the course. If it be admitted that for the sake of the student who is to use his mathematics in the physical, mechanical, and engineering sciences, the policy of allowing him to accept the truth of many propositions partly by analogy, partly by trial, and partly by faith is good policy, this principle can be appealed to not a little. To illustrate, when the pupil has proved the parallel proposition for lines and angles, he will see intuitively the truth of its space analogue for planes and diedrals, by merely drawing his attention to it.

The principle of the reduction of space geometry to plane geometry by the analysis of figures will orient the pupil with reference to nearly all the propositions of solid geometry.

All of us seem pretty well agreed as to the high value of what is commonly called inventional geometry. Most of us agree that one demonstration carefully thought out by the student is worth more to him than ten committed demonstrations. Suppose now that from a limited number of special cases exemplifying these organizing principles the student should be led to generalize them and then to verify his generalizations by confronting them with a few more special cases. Then suppose all the rest of what is commonly given in the course in geometry were to be put as exercises under these central principles. Would not such a method of presenting geometry stand for as much or more intellectual training, and for more power in the use of mathematics, than does the common text-book procedure?

But if we cannot bring ourselves to a willingness to break away from common practice so completely as this, can we not admit that this would at least be a good plan on which to conduct a final review? This question is strongly urged upon secondary mathematical teachers.

As to secondary algebra also much ought to be said if time would permit. In the first place, I advocate the abandonment of the attempt to teach secondary algebra with a view to making it a study of functions, or primarily an introduction to such study. I would have the weight of the pupil's attention on the equation and how to use it in the solution of practical problems, the drill on the solution of abstract functions coming in mainly as a means of enhancing the pupil's skill in handling such equations as occur in those branches

of science which make real demands for algebraic knowledge and skill.

I would in the second place advocate, for algebra as for geometry, a subdivision of the subject-matter more with reference to a small number of central principles. I do not believe in the educational value of the schoolman's tendency

To sever and divide
A hair 'twixt north and northwest side.

Thirdly, I am a believer in the early and continuous use of graphical representations for the reason that it is as well worth while to calk the joints of a leaky thought fabric as of a material fabric. I would not preface the construction of curves with a mass of definitions from analytical geometry; nor with a philosophical exposition of the possibility of drawing graphs to represent equations. I would draw graphs much as the fabled farmer raised potatoes. I would simply draw graphs.

The study of algebra, first, with emphasis upon the technique, and then again with emphasis upon the thought, ought to be discouraged; because skill in manipulation built upon either ignorance or faith in the existence of an adequate, though unseen, reason, or in any other way than upon a clear and cogent reason for it, is almost certain to produce shallow thinking. So far from discouraging the attempt to secure skill, I would emphasize it; but not at the risk of crippling the pupil's power of analysis, nor of fixing upon him the habit of being content with a rule-of-thumb knowledge of technique, without troubling himself with the *rationale*. Moreover, experience leads me to believe that both the thought and the technique can be more quickly and more adequately mastered than can technique either alone or with but secondary emphasis upon thought.

The presentation of the theory of exponents should lead the pupil to see that the order of reasoning is to assume the general tenability of the four fundamental exponential laws from a knowledge of their tenability for positive integral exponents, and then to interpret the meaning of fractional and negative exponents consistently with this assumption.

The text-book in algebra should be copiously illustrated, and the matter placed upon the page in such a way that the eye may readily catch the important ideas at a glance.

I would discourage the lecture method of imparting instruction to secondary mathematical classes

Better results may be attained by a competent teacher in both algebra and geometry by teaching these subjects abreast, even if time limitations reduce it to running a three-hour-a-week course through the first high-school year and a two-hour-a-week course through the last year before leaving the high school. In such event the last year's work should consist largely of trigonometrical work, which should have begun long before the algebra and geometry are completed. But mathematical expertness and insight are a growth, and there should be no period in the secondary school during which the study is suspended.

All through the work of the secondary school the largest importance should be given to practical considerations, on the hypothesis that the best definition for the elementary and secondary pupil is that "mathematics is the abstract form of the physical sciences." By this I do not mean that I would have the pupil in these grades have nothing to do with abstract work and ideas; but rather that the abstractions, so far as taken up, should grow out of practical questions relating to the concrete world. I would do this because, while I am more interested in making a mathematician than in producing any other form of specialist, I am most of all interested in doing what I can in the production of useful average citizens. We may all safely assume that the bulk of our pupils are candidates for this category. This method of procedure will do no harm to the thousandth student whose mental processes fit him for the peculiar work of the pure mathematician, while it will do great service to the 999 to whom practical questions make a stronger appeal than abstract matters, at least during the immature period of the high school. I believe most confidently that this method would curtail the mortality lists of the pre-university period and bring a much larger and finer assortment of material to the universities from which to select the pure mathematicians. With the larger number of specimens there would be all the more chance of finding the fish with the golden coin in its mouth. While the policy advocated by this paper may seem to make mathematical work play a subordinate part in education, I feel that this is but another case in which the servant finds his life by losing it. If it can be shown to the young pupil that a mastery of mathematics means the enhancement of his power an hundredfold in whatever line he seeks advancement, he will not shirk it as he will when he feels that the main reason he should study it is to discipline his mind. Still I would not for a moment advocate a presentation of mathematics which does

not make proper provision for the element of mental discipline. It is too remote and abstract an ideal, however, to make a strong appeal to the immature pupil. The rational handling of real problems cannot fail to secure the necessary mental discipline.

Finally, I may confess that I suspect most of the mathematical ills that now afflict elementary and secondary teaching would be greatly relieved, if not cured, by the influx into these grades of school work of a large number of well trained and ambitious men and women. I hope to see the day when it will be the rule, rather than the exception, to find at the head of the work in each grade above the sixth a man or woman who has had enough interest in the higher training of the mind to have pushed his or her studies at least as far as the bachelor of arts degree in a good institution of learning. This will insure the teacher the much-needed *margin*, without which no teacher can do his best service, and no true teacher is ever satisfied to do less than his best. Furthermore, elementary and secondary teachers cannot much longer excuse their lack of training on the grounds that many university trained persons fail to make good teachers. The day is not far distant when it will be a generally recognized fact that the function of the university is not to furnish the steel, but merely to put an edge on what is furnished. Pewter will not then be expected to furnish the same results as steel, even if both metals are put through the same course of treatment. The deprecation of university training will soon come to be "seen in its true nature," as merely a ruse to disarm deserved criticisms upon the critic's self-imposed shortcomings, for there will soon be no good reason — if, indeed, there is now a good reason — why anyone by the exercise of a little determination and self-denial need forego the advantages of a university education. It will then be recognized that he who has the steel and fails to give it an edge is more deserving of censure than he who having but an inferior grade of metal has done his best to make it useful. May this day speedily come !